WATER WORKS & SEWERAGE

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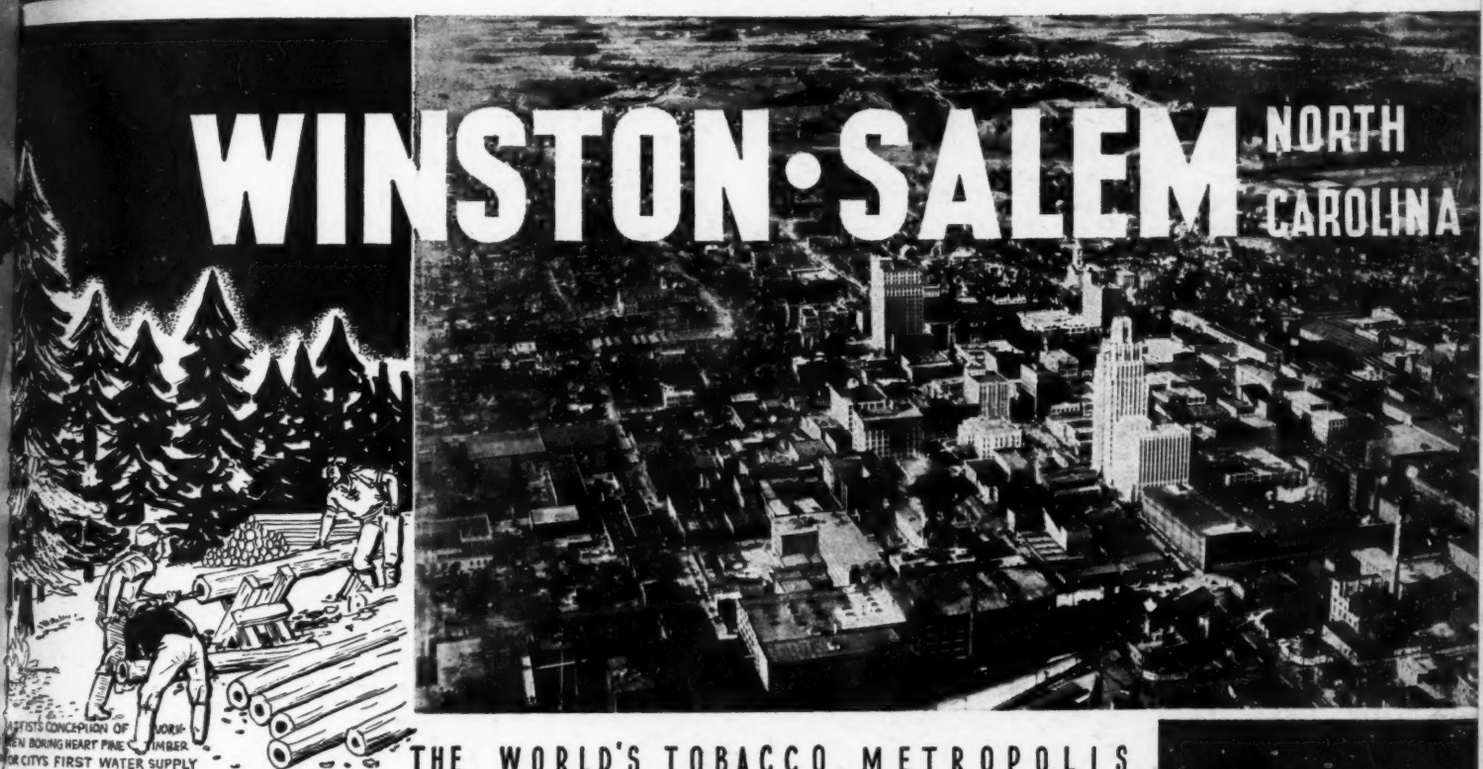


THE WORLD'S TOBACCO METROPOLIS

WINSTON-SALEM, old in colorful tradition and historic buildings, modern in industrial development and supremacy, is located in the famous Piedmont section of North Carolina. From the day it was founded, 170 years ago, the community has combined an inquiring interest in all that was new with an appreciation of the already proved, into a practical progressiveness that has made it the industrial center of the Southeast.

Salem began on paper with a city plan that took into account such needs as water supply, sewerage and streets. The first water works system, completed on March 25, 1778, aroused the enthusiastic comments of President Washington when he visited the community on his presidential tour in 1791. From a good spring more than a mile away, water was brought by gravity to the main street, and thence distributed to various stations. The pipes were of the best heart pine timber, carefully hollowed, with the ends trimmed and fitted into each other. Terra cotta pipes were laid in 1828, when a triple pump and overshot power wheel were installed.

"Always in the van of progress" might well be the motto of this progressive Southern city that today, as well as yesterday, gives first thought to its pure and plentiful water supply. This comes today from two surface streams on parallel watersheds, with a normal dry weather flow of 2 M. G. D. on one, and 8 to 10 M. G. D. on the other.

Once measured by bucketfuls as it flowed from the wooden pipes, Winston-Salem's water supply is now checked by Pittsburgh Water Meters.

WINSTON-SALEM 1850 1766 1913 N★C URBS CONDITA ADIUVANDO

PITTSBURGH EQUITABLE METER CO.

MERCO NORDSTROM VALVE CO.

MAIN OFFICES PITTSBURGH, PA.

NEW YORK	LOS ANGELES	TULSA	HOUSTON	MEMPHIS	BUFFALO
COLUMBIA	KANSAS CITY	CHICAGO	PHILADELPHIA	ATLANTA	OAKLAND

Lithographed on stone by James E. Allen for U. S. Pipe & Foundry Co. Copyright 1937.

NINE GENERATIONS of engineers have put their trust in cast iron pipe for underground mains requiring structural strength and effective resistance to corrosion. History vindicates their judgment. For cast iron pipe has proved its case beyond question as the most enduring and economical material for the purpose. But cast iron pipe founders are not resting on their laurels. U. S. Super-de Lavaud *Chill-Free* Cast Iron Pipe, bottle-tight mechanical joints, alloy cast iron pipe for super-corrosive conditions—all are developments of recent years.

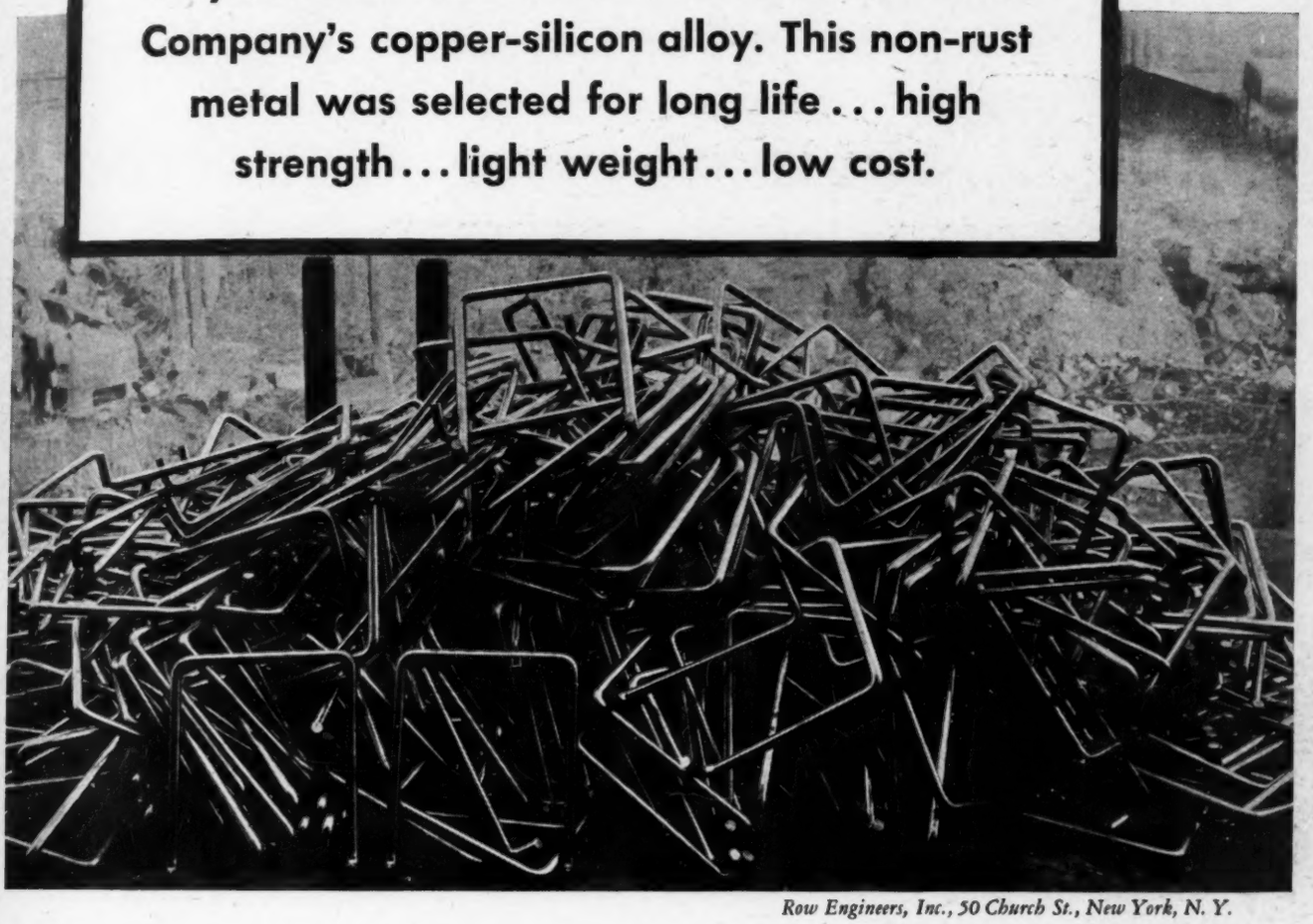
U.S. cast iron PIPE

Cast iron and alloy cast iron pipe centrifugally or pit cast—for water works, gas, sewerage and drainage service as well as industrial uses involving corrosives.

U. S. PIPE & FOUNDRY CO.
BURLINGTON, NEW JERSEY
Foundries and Sales Offices throughout the U. S.

1,000 MANHOLE STEPS WHICH CAN NEVER RUST

They're made of Everdur...The American Brass Company's copper-silicon alloy. This non-rust metal was selected for long life... high strength... light weight... low cost.



Row Engineers, Inc., 50 Church St., New York, N. Y.

1,000 *EVERDUR Manhole Steps for installation in a storm sewer system at Rahway, N. J. They are made from ¾" hot rolled EVERDUR* "1010" *rods bent cold to shape. Each step weighs 5½ lbs.*

• • •

EVERDUR is rustless as copper yet strong as steel. It can be fabricated easily and is available in all ordinary commercial shapes.

This Anaconda Metal has a ten-year record of successful service in the sewage field in the form of screens, swing and sluice gates, bar rack aprons, effluent and scum weirs, baffle brackets, troughs, orifices, nuts and bolts, electrical conduit, and numerous other applications. Anaconda Publication E-11 tells the complete story. 37389

Everdur Metal

RUSTLESS AS COPPER
STRONG AS STEEL

THE AMERICAN BRASS COMPANY, General Offices: WATERBURY, CONNECTICUT

Offices and Agencies in Principal Cities • In Canada: ANACONDA AMERICAN BRASS LTD., New Toronto, Ontario

"EVERDUR" is a trade-mark of The American Brass Company, registered in the United States Patent Office.

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CITIES,...
MAKE A CHEAP COMPOST
for your
Municipal Parks & Gardens

Machines made in four sizes—either belt, gasoline engine or electric drive.

USING THE
ROYER DISINTEGRATOR

A Royer Disintegrator Will Pay for Itself

The Royer Sludge Disintegrator will rapidly and economically shred sludge containing from 30 to 60 per cent moisture into fine particles at a cost of thirty cents or less per cubic yard. The smallest size disintegrator will shred 2 cubic yards per hour using a ¾ H. P. motor. Operating costs are therefore very low, as also are maintenance and repair costs.

In many instances the cheap supply of compost for municipal parks, lawns and gardens will soon pay for the disintegrator.

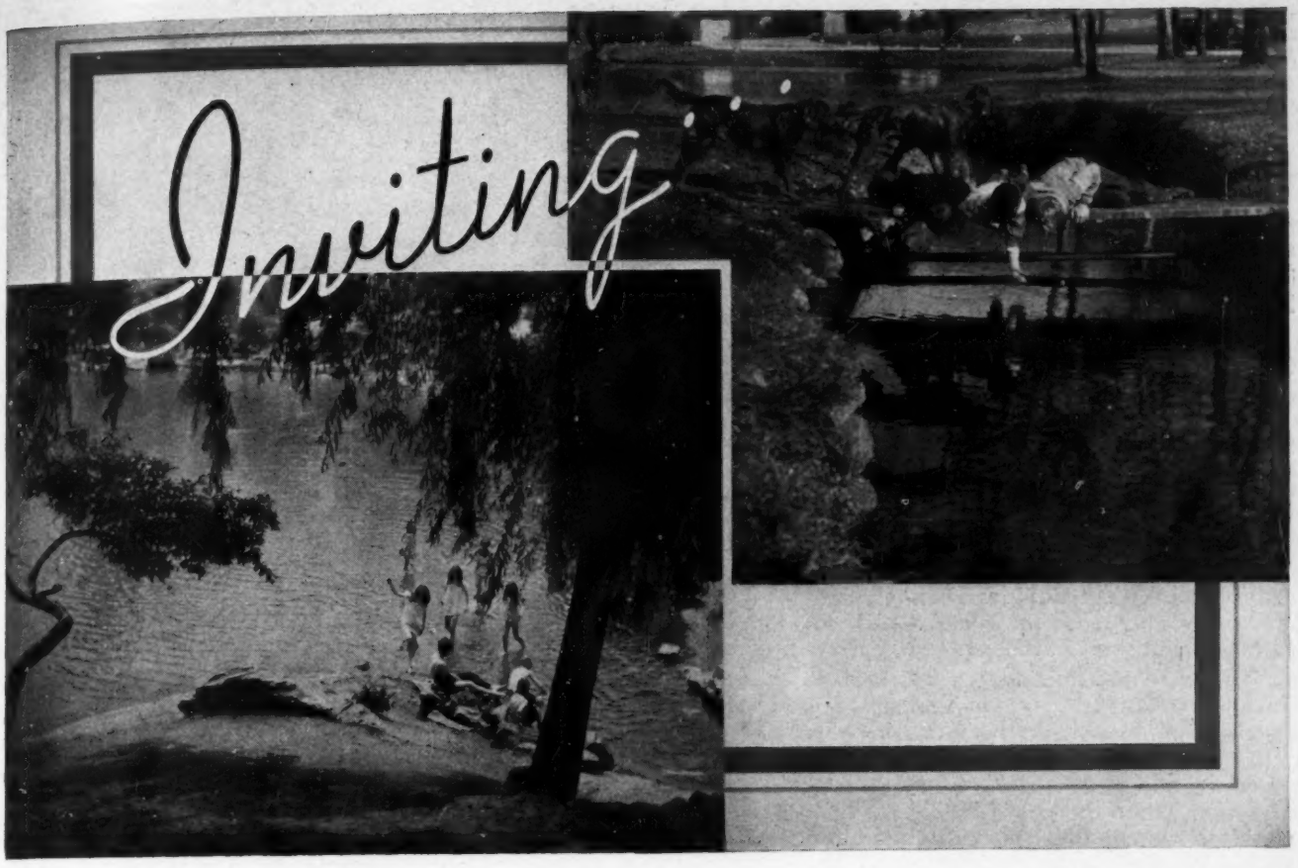
In the past the organic matter for lawns, parks and gardens was derived largely from animal manure, but in recent years this source of supply has practically disappeared. It is as a substitute for this material that sewage sludge should be utilized. It should not be wasted.

Let us send you details of the machine and interesting information on the value of Disintegrated sludge as a fertilizing compost.

ROYER FOUNDRY & MACHINE CO.

158 Pringle St. — Kingston, Pa.

C. G. WIGLEY, Sole Rep.
3108 Atlantic Ave., Atlantic City, N. J.



● Water has a great attraction to all of us. The same sunshine that has made the water so inviting to the youngsters, likewise is the cause of many a headache to the Plant Operator confronted with tastes and odors due to algae growth, etc. Fortunately, there is a means of relieving the Operator of his worries . . . . AQUA NUCHAR.

Since its introduction to the water field, AQUA NUCHAR has been applied in over 1,000 Plants in the United States—and in 47 of the 48 States.

In a paper read by E. A. Sigworth at the 4-States Section Meeting of the American Water Works Association, Philadelphia, Pa., April 22-24, 1937, it was pointed out, from a summary representing a cross-section of returned Questionnaires, that but few plants reported difficulty in removing tastes and odors with Activated Carbon. These few cases reported were due to the inability to feed sufficient carbon to take care of a very heavy industrial pollution.

The warm weather always increases the need of water for drinking purposes — MAKE IT INVITING TO DRINK — MAKE IT SPARKLING—MAKE IT PALATABLE—(so easy to do with AQUA NUCHAR).

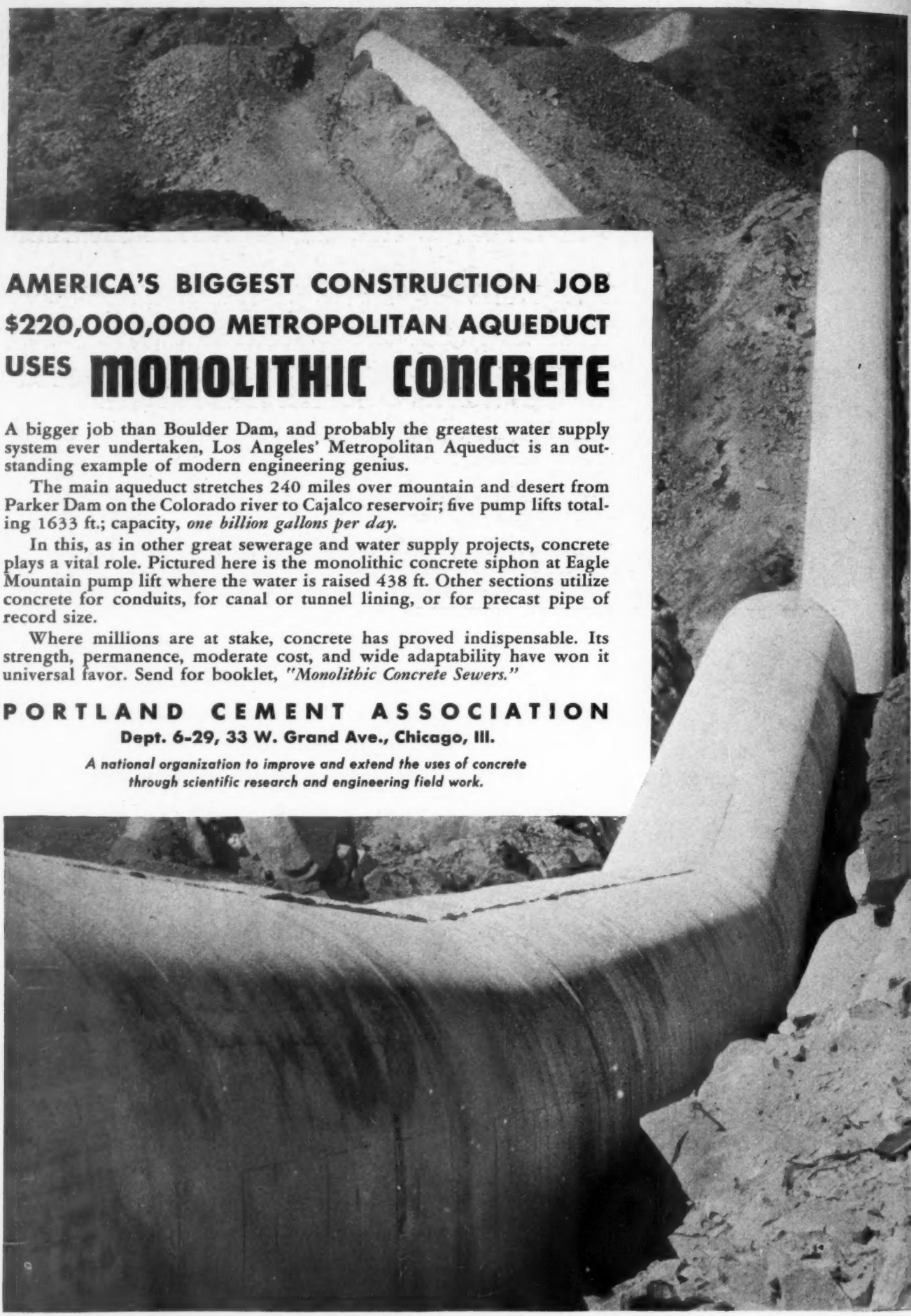
INDUSTRIAL CHEMICAL SALES

DIVISION WEST VIRGINIA PULP AND PAPER COMPANY

230 Park Ave., New York, N. Y.

417 Schofield Bldg., Cleveland, Ohio

205 West Wacker Drive, Chicago, Ill.



AMERICA'S BIGGEST CONSTRUCTION JOB
$220,000,000 METROPOLITAN AQUEDUCT
USES MONOLITHIC CONCRETE

A bigger job than Boulder Dam, and probably the greatest water supply system ever undertaken, Los Angeles' Metropolitan Aqueduct is an outstanding example of modern engineering genius.

The main aqueduct stretches 240 miles over mountain and desert from Parker Dam on the Colorado river to Cajalco reservoir; five pump lifts totaling 1633 ft.; capacity, *one billion gallons per day.*

In this, as in other great sewerage and water supply projects, concrete plays a vital role. Pictured here is the monolithic concrete siphon at Eagle Mountain pump lift where the water is raised 438 ft. Other sections utilize concrete for conduits, for canal or tunnel lining, or for precast pipe of record size.

Where millions are at stake, concrete has proved indispensable. Its strength, permanence, moderate cost, and wide adaptability have won it universal favor. Send for booklet, *"Monolithic Concrete Sewers."*

PORTLAND CEMENT ASSOCIATION

Dept. 6-29, 33 W. Grand Ave., Chicago, Ill.

A national organization to improve and extend the uses of concrete through scientific research and engineering field work.

FIRE FLOOD OR other emergency

Perchloron OFFERS PROTECTION

A case of Perchloron can be just like a spare tire for your car —ready in case of emergency. It is equally valuable for swimming pool sanitation, water purification, or sewage treatment.

Perchloron has an available chlorine content of more than 70%. It is stable as well as concentrated. It dissolves quickly in water, and is perfectly uniform. Packed in 12 handy-sized cans to the case—no return containers to bother with.

Send for this free booklet

Here is a new, 36-page booklet on the uses of Perchloron. In addition, it covers such subjects as emergency feeding, preparing Perchloron solutions, determination of residual chlorine, and many others of interest. You will find it extremely valuable for general reference. Send for it now—it is free.

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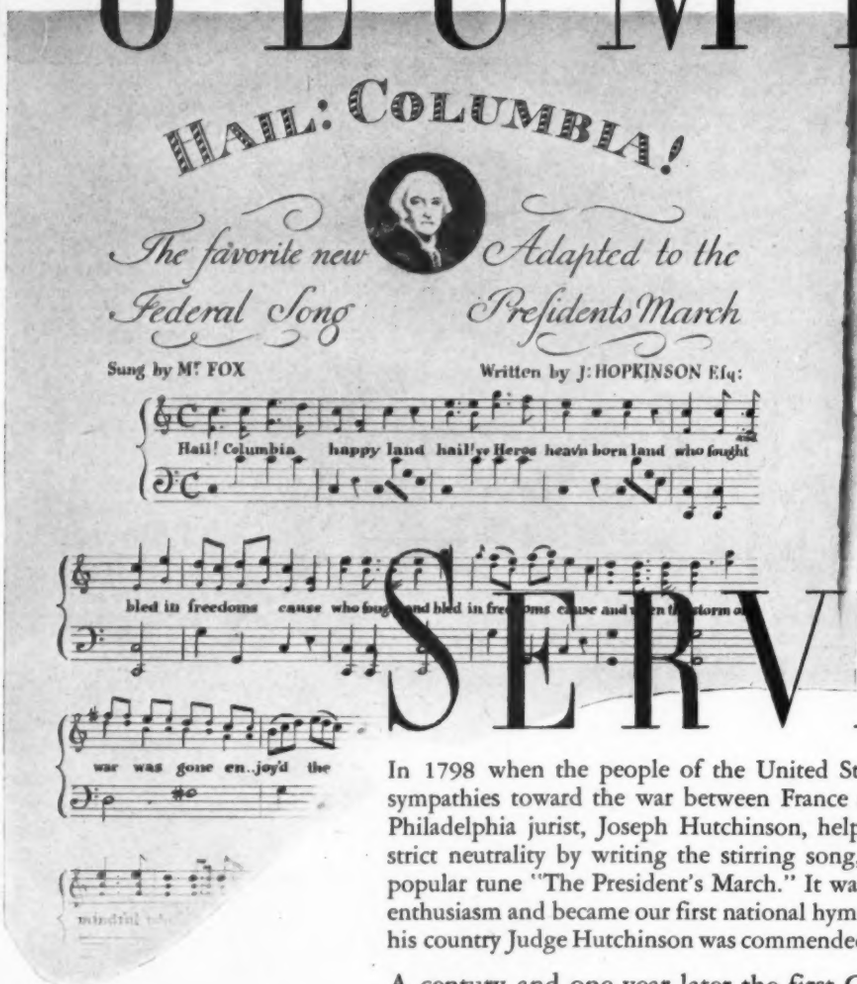
WIDENER BLDG., PHILADELPHIA, PA.
Offices: New York · Chicago · St. Louis · Pittsburgh · Tacoma · Wyandotte

PENNSYLVANIA SALT *Chemicals*

Hail COLUMBIA SERVICE


HAIL: COLUMBIA!
The favorite new Federal Song
Adapted to the Presidents March
Sung by Mr FOX
Written by J: HOPKINSON Esq:
Hail! Columbia happy land hail! ye Heros heavn born band who fought
bled in freedoms cause who fought and bled in freedoms cause and
war was gone en..joy'd the

Theatre on Chestnut St. Philadelphia, where "Hail; Columbia" was first sung.

In 1798 when the people of the United States were divided in their sympathies toward the war between France and England, the eminent Philadelphia jurist, Joseph Hutchinson, helped to unite the country in strict neutrality by writing the stirring song, "Hail; Columbia," to the popular tune "The President's March." It was greeted with tremendous enthusiasm and became our first national hymn. For this signal service to his country Judge Hutchinson was commended by President Washington.

A century and one year later the first Columbia Soda Ash was produced at Barberton, Ohio. Since that year Columbia Alkalies have performed an increasingly important service to industry. Development and expansion have kept pace with the ever-increasing demands. By production in forms and grades best suited to the particular industry served; by shipments in containers and units which meet individual mill requirements; by opening new sales offices and warehouses in centers of consumption; Columbia has won and holds today an outstanding position as supplier of Soda Ash, Caustic Soda, Bicarbonate of Soda, Modified Sodas, Calcium Chloride, Liquid Chlorine, and other products.

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COLUMBIA LIQUID CHLORINE

(In Single and Multiple Unit Tank Cars, 100 and 150 lb. Cylinders.)

Other COLUMBIA Products

SODA ASH
CAUSTIC SODA
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Send for new folder on COLUMBIA Liquid Chlorine.

THE COLUMBIA ALKALI CORPORATION

BARBERTON • OHIO

NEW YORK CHICAGO BOSTON PITTSBURGH
CLEVELAND CINCINNATI MINNEAPOLIS

ELEVATED STORAGE

at University Park, Texas

saves 15 per cent

in operation costs alone!

AS elevated storage goes up, power demand charges come down! — This is the record at University Park, Texas, where the 500,000-gal. Horton ellipsoidal bottom tank, illustrated at the left, is installed.

When this improvement was planned it was found that the most economical method of operation was to use a continuous running pump with enough excess capacity to keep the tank filled well above the minimum for taking care of all periods of peak consumption. The saving secured thus by eliminating extra demand charges amounts to approximately $200.00 per month. With a uniform pumping pressure of 80 lbs. the pressure in the distribution system ranges from 60 lbs. upward, depending on such factors as elevation and distance from station.

Economy resulting from lowered power costs is only one of many advantages to be had from elevated storage. There is, for instance, the benefit of a dependable uniform pressure. This offers a convenience to domestic users, a material aid to industrial users and is of vital importance to adequate fire protection.

Our nearest office will gladly supply waterworks engineers and municipal officials with information regarding the experience of other cities with elevated storage or cost data for estimating purposes.

CHICAGO BRIDGE & IRON COMPANY

Chicago.....2198 Old Colony Bldg.	Dallas.....1479 Liberty Bank Bldg.	Houston.....2919 Main Street	Boston.1548 Consolidated Gas Bldg.
New York.3390-165 Broadway Bldg.	Birmingham.1586 North 50th Street	Detroit.....1551 Lafayette Bldg.	San Francisco....1083 Rialto Bldg.
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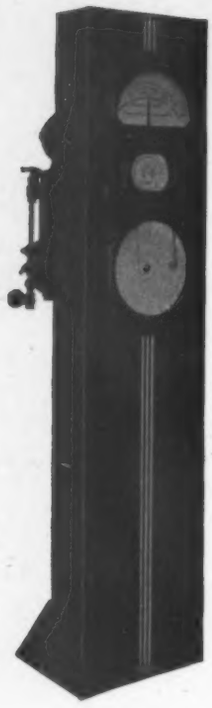
Fabricating plants in CHICAGO, BIRMINGHAM, and GREENVILLE, PA.

TYPE M REGISTER-INDICATOR • • • • RECORDER • • • •



New Model D features:

1. Retention of previous sturdiness and simplicity plus numerous improvements in mechanism and general design.
2. Twenty-one inches of mercury differential capacity with powerful float actuation.
3. Wider measuring range.
4. No possibility of air trapping; air vents at highest points over mercury chambers.
5. Easily set up, adjusted, and placed in operation.
6. Long, separate Indicator dial at eye level; no "stooping."
7. Entire chart record of flow rate visible from front of instrument.
8. Six-dial Totalizer, 4½" diameter.
9. Chart and Totalizer driven by electric motor or mechanical clock movement, as selected.
10. Dials mounted in neat steel cabinet with modern "switchboard" effect. Wall or separate panel mounting possible.
11. Indicator and Totalizer dials of white pyralin and all dials *illuminated* from the interior. Main case finished in black and embellished with chromium strips. An addition to the appearance of any plant.
12. Chronoflo long distance transmitting and summation attachments now available.

Write for new Bulletin 291, address:

BUILDERS IRON FOUNDRY VENTURI "VENTURI"-Registered **9 CODDING ST., PROV., R. I.**

Dependable . . .

GOLDEN-ANDERSON
Pat. Automatic Cushioned Water Float Valves

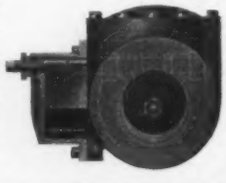
● Float Control Valve for high or low pressure service which can function on any desired water level variation desired. No water hammer or shock due to air and water cushioning. Furnished in angle or globe patterns ½" to 24" sizes in bronze, iron body or steel. No metal contacts assure lifetime service.

GOLDEN-ANDERSON
Pat. Cushioned Automatic Controlling Altitude Valves

● Altitude Valve assures perfect water-level control in tanks, standpipes and reservoirs. Always function without any water surge or shock due to efficient air and water cushioning. Furnished with automatic, electric and manual control, and for single or double-action service.

GOLDEN-ANDERSON
Pat. Cushioned Swing Check Valves

● Cushioned Swing Check Valve is non-slam due to perfect cushioning chamber. Minimum friction loss through valve and soon pays in power cost savings. Furnished in all sizes 4" and larger for all service conditions and pressures. Easily equipped with lever for manual control.



Golden-Anderson Valves assure you of unfailing and economical service. They have been designed by engineers whose efforts for more than 30 years have been devoted to the design and construction of the very best valves it is possible to make.

GOLDEN-ANDERSON VALVE SPECIALTY CO.
1329 FULTON BLDG. PITTSBURGH, PA.

Porous Mediums That Meet More Efficiently the Individual Requirements of Different Plants . . .

Because of CONTROLLED STRUCTURE

Controlled Structure is an exclusive patented Norton achievement and assures the user a porous product with just the physical characteristics necessary to meet the individual requirements of his plant.

Plates for aeration of sewage must have a low wet pressure loss, low rate of clogging and efficient aeration. Norton Porous Plates meet these requirements. By combining Structure Control with grain sizing control, Norton can supply:

Coarse plates of high permeability

Coarse plates of low permeability

Fine plates of low permeability

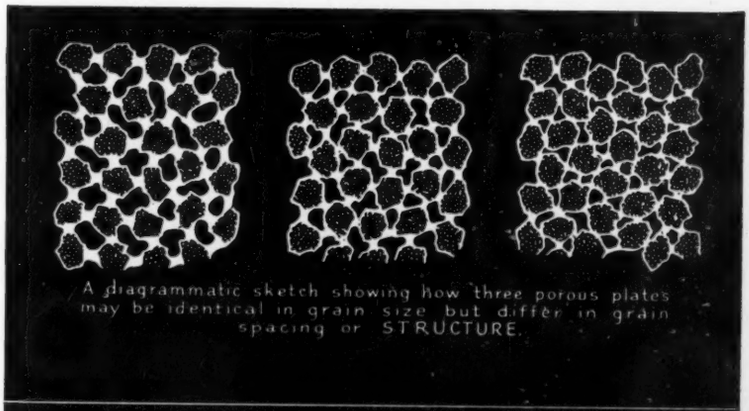
Fine plates of high permeability

Plates to deliver small bubbles or

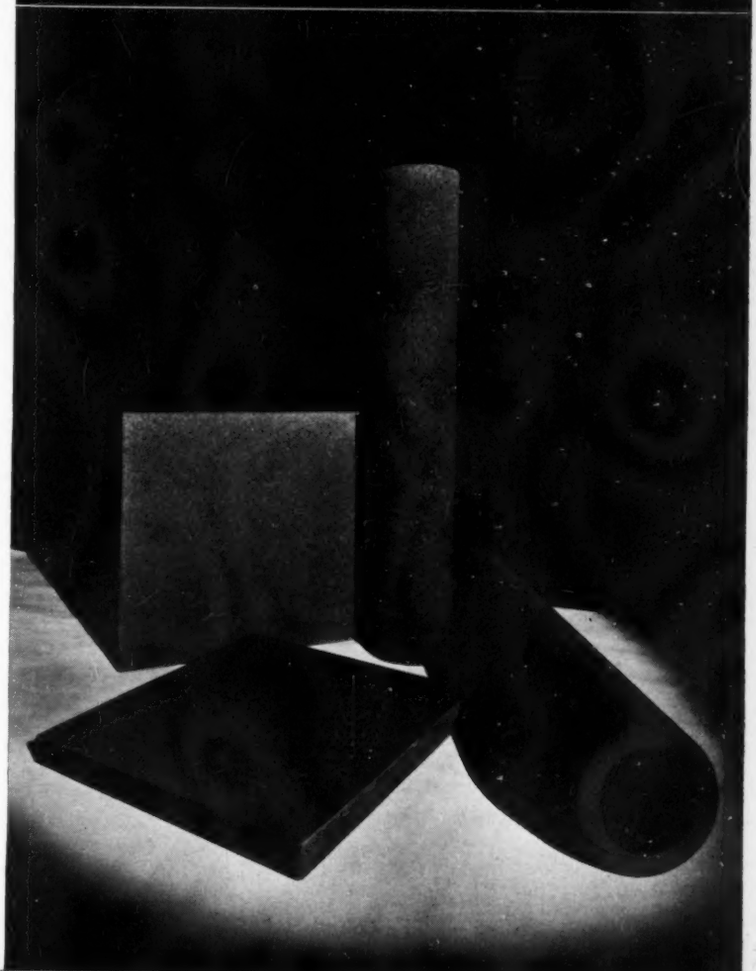
Plates to deliver large bubbles as required

The performance of Norton Porous Mediums has been proved by many years of service in plants from the Atlantic to the Pacific, from the Great Lakes to the Rio Grande, and in foreign countries.

Because of their proved performance, because of the experience of Norton engineers and because of the careful control in the manufacture and testing of Norton Porous Mediums they are becoming more and more widely used—are standard in many plants.



A diagrammatic sketch showing how three porous plates may be identical in grain size but differ in grain spacing or STRUCTURE.



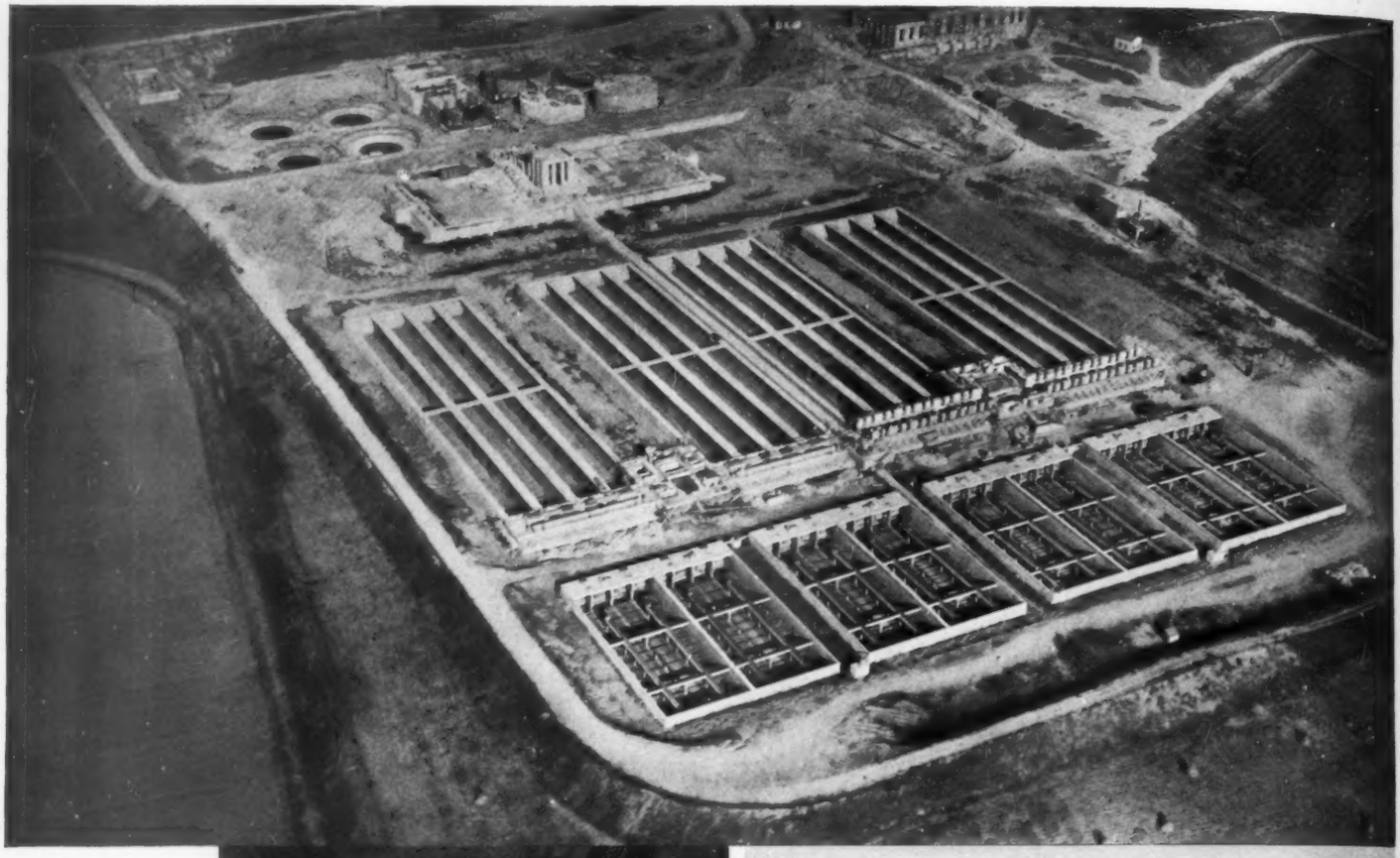
NORTON COMPANY
Worcester, Mass.

New York Chicago Cleveland

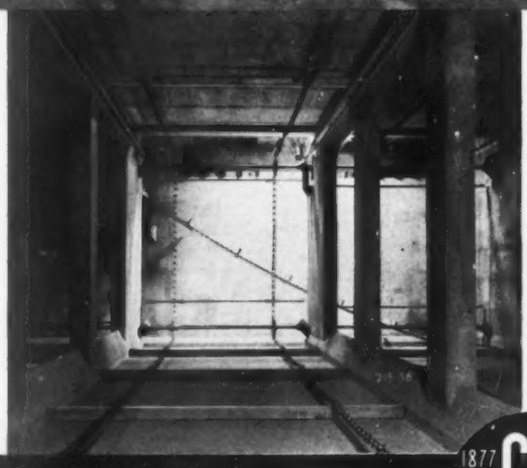
R-564

NORTON POROUS MEDIUMS

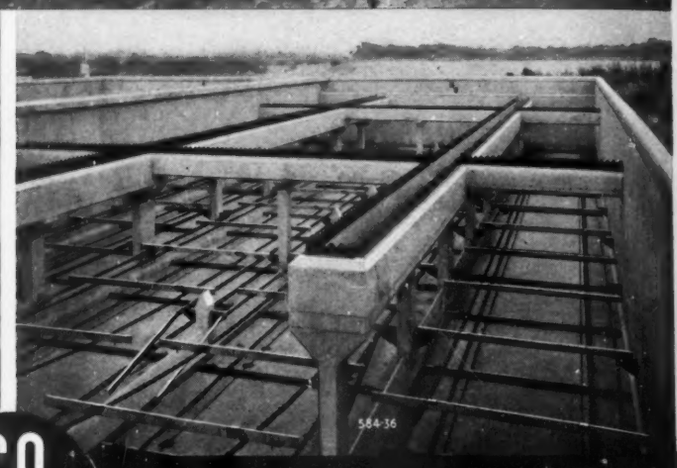
Your Community can Build



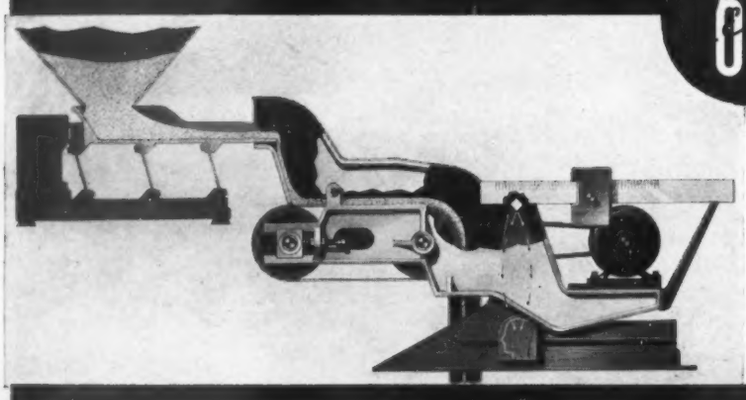
The airplane view above gives a fairly good picture of the sewage disposal plant in Columbus, Ohio. This new project, modern in every detail, is but one of the many plants using Jeffrey equipment.



A section of the primary settling tanks (right) in the Columbus plant showing the Jeffrey sludge collectors.



1877 60 1937



Above, a section of the secondary settling tanks in the Columbus plant plainly seen. Cooperating with the plant-design engineers, Jeffrey sanitary engineers designed this equipment so that all the drives, countershafts and clutches are located under the top slab, to protect them from the weather and improve the plant appearance. Cone type submerged bearings prevent sludge accumulation on the bearings below the surface.

The Jeffrey-Traylor "Waytrol" (left) is a precision machine which delivers by weight rather than by volume . . . and is applicable to the continuous weigh-feeding of reagents in sewage disposal and water purification plants.

to Better Standards . . . . . .

If it uses JEFFREY Sewage Treatment Equipment

More and more are growing cities conscious of the importance of doing things in a better way . . . of meeting the needs of growing populations . . . of building and rebuilding their public works to higher civic and health standards.

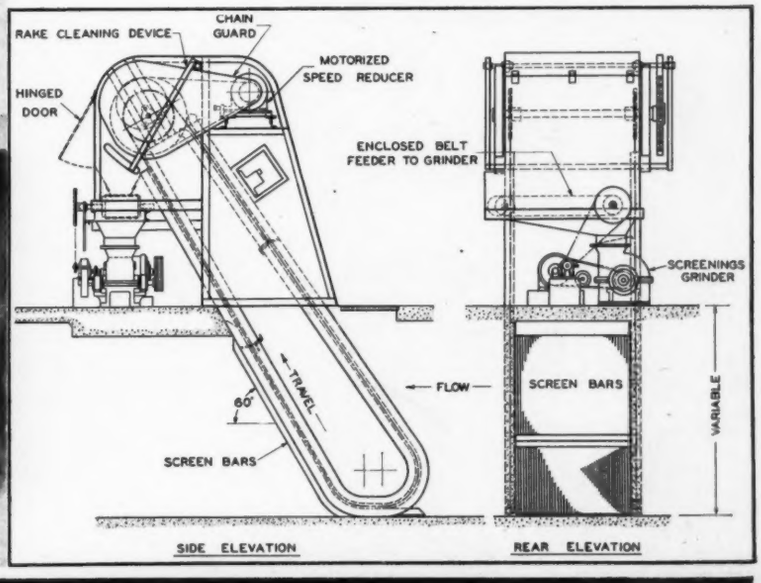
What could be more important than the purification plants which treat millions of gallons of water and sewerage daily . . . the preservers of public health? Doesn't this phase of your public endeavor mean a search for the latest and most efficient purification facilities available?

By continuing development Jeffrey equipment is made to meet each new rise in the standards demanded by progress. Jeffrey sewage disposal equipment has proved its merit in many of the largest plants throughout the country . . . by outstanding performance, with power economy and low-cost maintenance.

Our sanitary engineers, intimately familiar with all phases of sewage and water treatment, will be glad to submit recommendations . . . without obligation.

Left, the improved Jeffrey mechanically cleaned bar screen. Fully automatic, it has features not found in other sewage screens. When working in conjunction with a Jeffrey screenings grinder (see drawing below) it is a highly efficient way of disposing of sewage screenings. The Jeffrey bar screen has no sprockets and shafts at the bottom . . . clear openings on the sides do away with obstructions in the submerged portion.

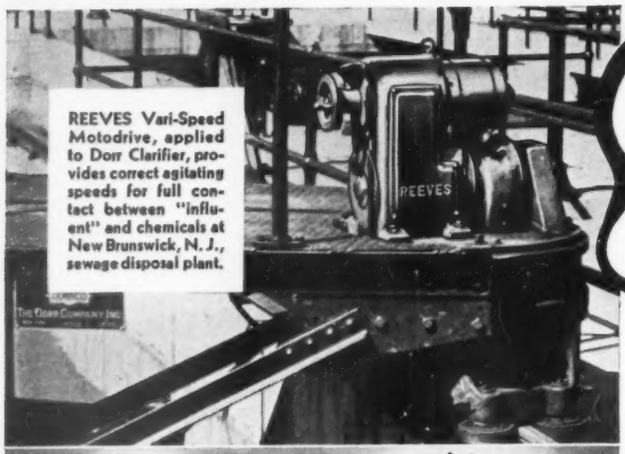
Line drawing (below) of combined screen and grinder. Unusually flexible, this unit may be designed to suit any depth or width of channel and may be installed at any angle from 45° to vertical. This combination has completely solved the problem of final disposal of sewage screenings.



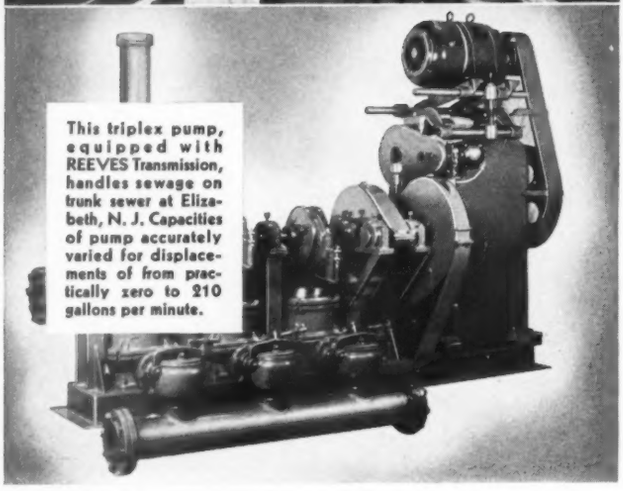
SANITARY DIVISION

The Jeffrey Manufacturing Company

996-99 North Fourth Street, Columbus, Ohio



REEVES Vari-Speed Motodrive, applied to Dorr Clarifier, provides correct agitating speeds for full contact between "influent" and chemicals at New Brunswick, N. J., sewage disposal plant.



This triplex pump, equipped with REEVES Transmission, handles sewage on trunk sewer at Elizabeth, N. J. Capacities of pump accurately varied for displacements of from practically zero to 210 gallons per minute.

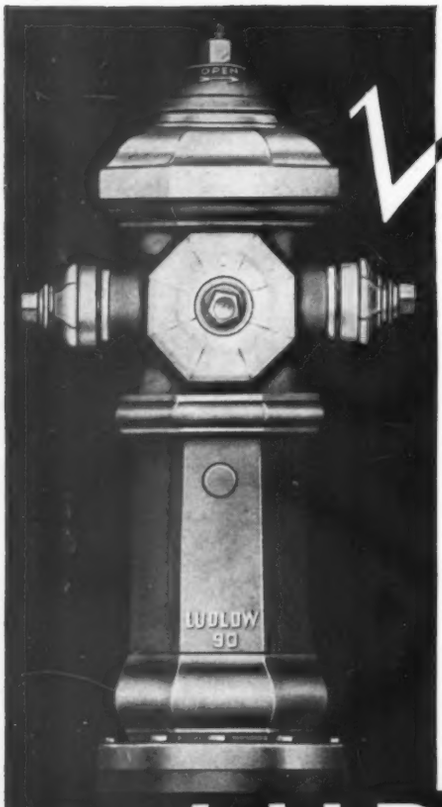
How MODERN SEWAGE PLANTS SECURE NEW EFFICIENCY AND FLEXIBILITY

Modern sewage disposal plants all over the country are constantly finding new uses for REEVES Speed Control, as provided by the REEVES Transmission, Vari-Speed Motor Pulley and Motodrive . . . These efficient, time-tested units make it *easy* to compensate in speed for every varying factor. Their instant, accurate selectivity assures *correct* operating speeds to match changes in rate of flow, volume, consistency of solids, moisture content, bacteria count, etc. . . . Complete REEVES line provides exactly the right size, design, speed range and control for application to chemical feeders, proportioning pumps, screens, filters, clarifiers, dryers, mixing tanks. Perfect synchronization of related machines and processes . . . Send for FREE copy of new, 118-page Speed Control Handbook, the most complete and authoritative book on speed regulation ever published.

REEVES PULLEY COMPANY, Dept. 5-37, COLUMBUS, IND.

★ MODERN
★ ACCURATE
★ TIME-TESTED

REEVES SPEED CONTROL



✓Check LUDLOW Hydrants

Check these points about the Ludlow No. 90 hydrant—

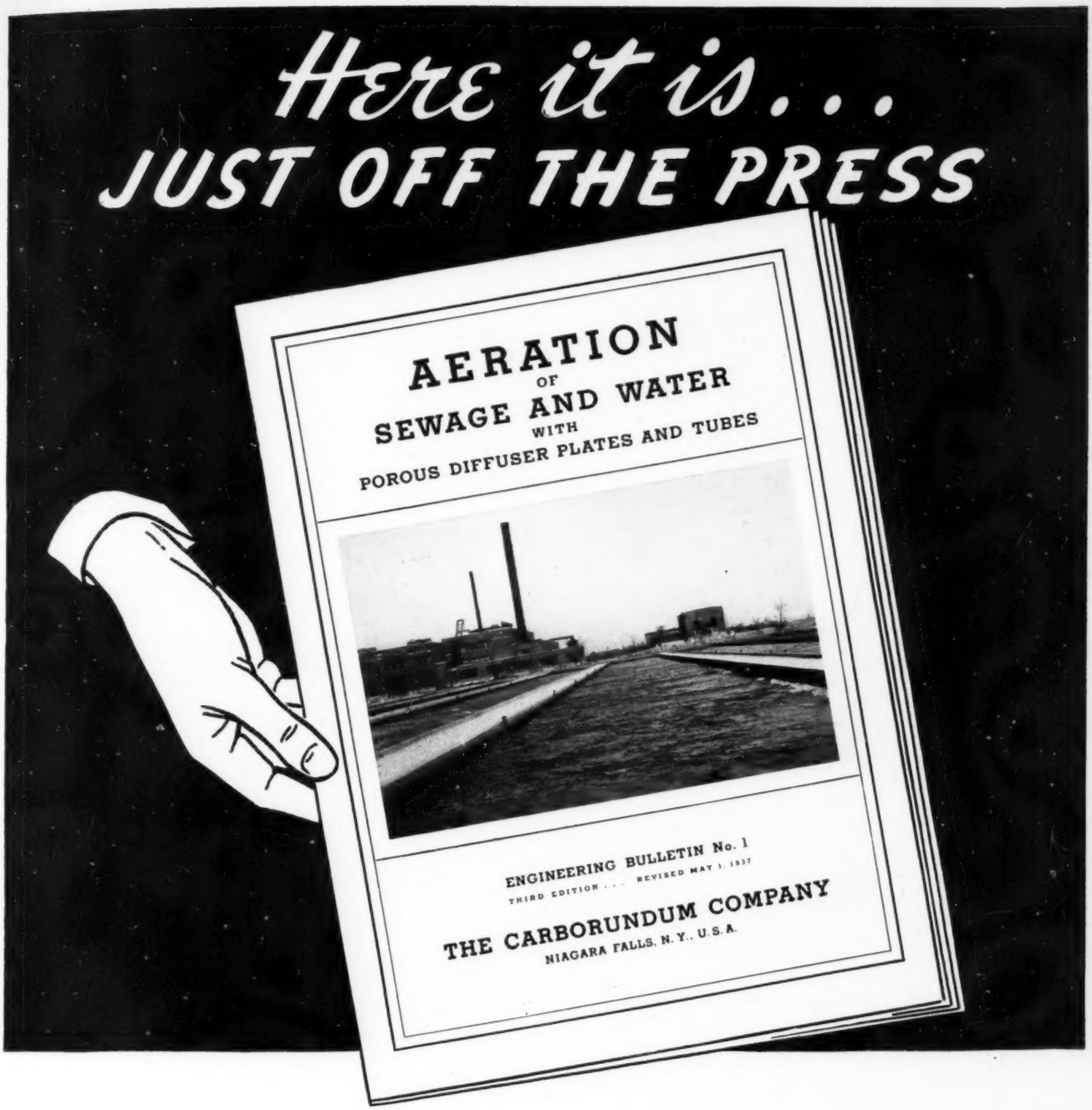
- ✓ Full force—no obstruction in waterway
- ✓ Non-freezing—drains from bottom
- ✓ Surge and water hammer eliminated
- ✓ Replaceable without digging
- ✓ Parts easily removable—low maintenance

— and finally, the most modern, graceful design obtainable.

SEND FOR FREE FOLDER

The LUDLOW VALVE MFG. CO.
TROY · NEW YORK

Here it is... JUST OFF THE PRESS



THIS new revision covers all applications of porous diffusers as used in sewage and water treatment plants. It provides the complete information and data which are essential to the study, design, installation and operation of such plants. • You will find this publication to be an authoritative and useful technical reference — a valuable text which has been needed for many years in the form now available. Send for a copy.

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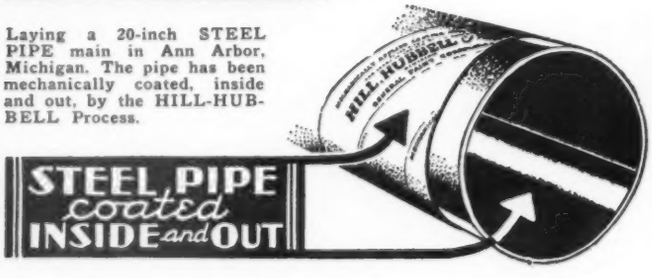

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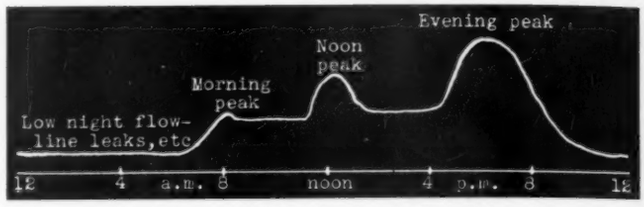
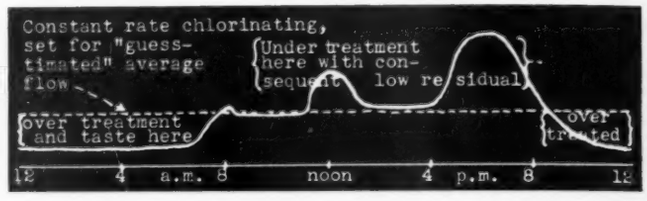
1. Have a piping system like this: . . . . . .

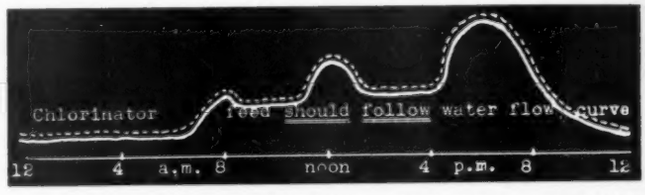
2. Have a variable 24-hour flow like this: . . .



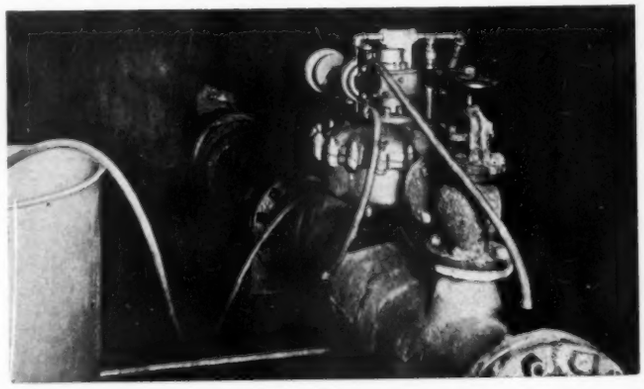
3. Formerly were chlorinated like this: . . . . .


Constant rate chlorinating, set for "guesstimated" average flow
Under treatment here with consequent low residual
over treatment and taste here
over treated
12 4 a.m. 8 noon 4 p.m. 8 12

4. Should be proportionally chlorinated like this:



5. Using PROPORTIONAL CHLOR-O-FEEDER:



Meter-paced proportional Chlor-O-Feeder measures every gallon of water passing through the line, and injects the proper amount of hypo-chlorite to automatically ***insure proper residual*** and to ***prevent taste.***

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*Webster's Dictionary: Triturate — to comminute thoroughly.

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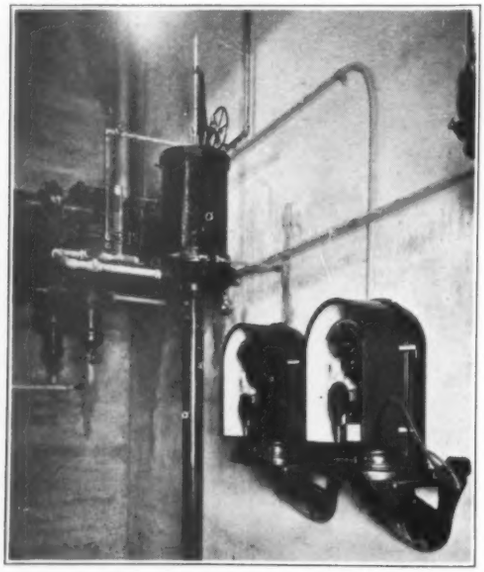

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Designed for installation on .005 grades, the instrument's response will be within plus or minus 2% over a range of from 100 to 1.

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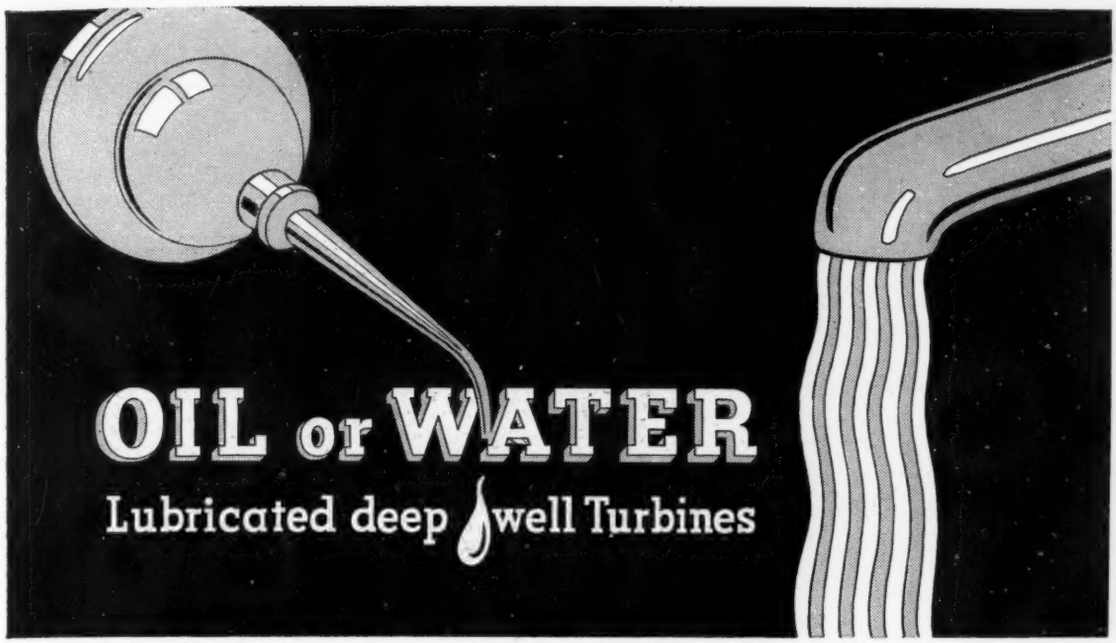

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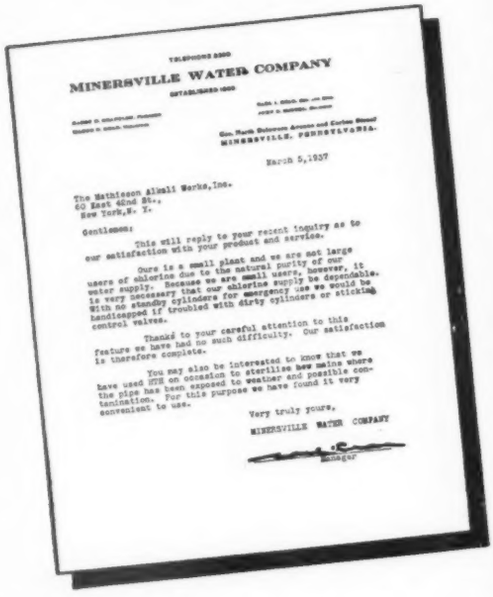
This letter shows how Mathieson Chlorine and HTH have helped maintain this record.



TELEPHONE 2000

MINERSVILLE WATER COMPANY

ESTABLISHED 1855

Geo. Earle Dobbs, Attorney and Corbin Street
MINERSVILLE, PENNSYLVANIA.

March 5, 1937

The Mathieson Alkali Works, Inc.
60 East 42nd St.,
New York, N. Y.

Gentlemen:

This will reply to your recent inquiry as to our satisfaction with your product and service.

Ours is a small plant and we are not large users of chlorine due to the natural purity of our water supply. Because we are small users, however, it is very necessary that our chlorine supply be dependable. With no standby cylinders for emergency use we would be handicapped if troubled with dirty cylinders or sticking control valves.

Thanks to your careful attention to this feature we have had no such difficulty. Our satisfaction is therefore complete.

You may also be interested to know that we have used HTH on occasion to sterilize new mains where the pipe has been exposed to weather and possible contamination. For this purpose we have found it very convenient to use.

Very truly yours,

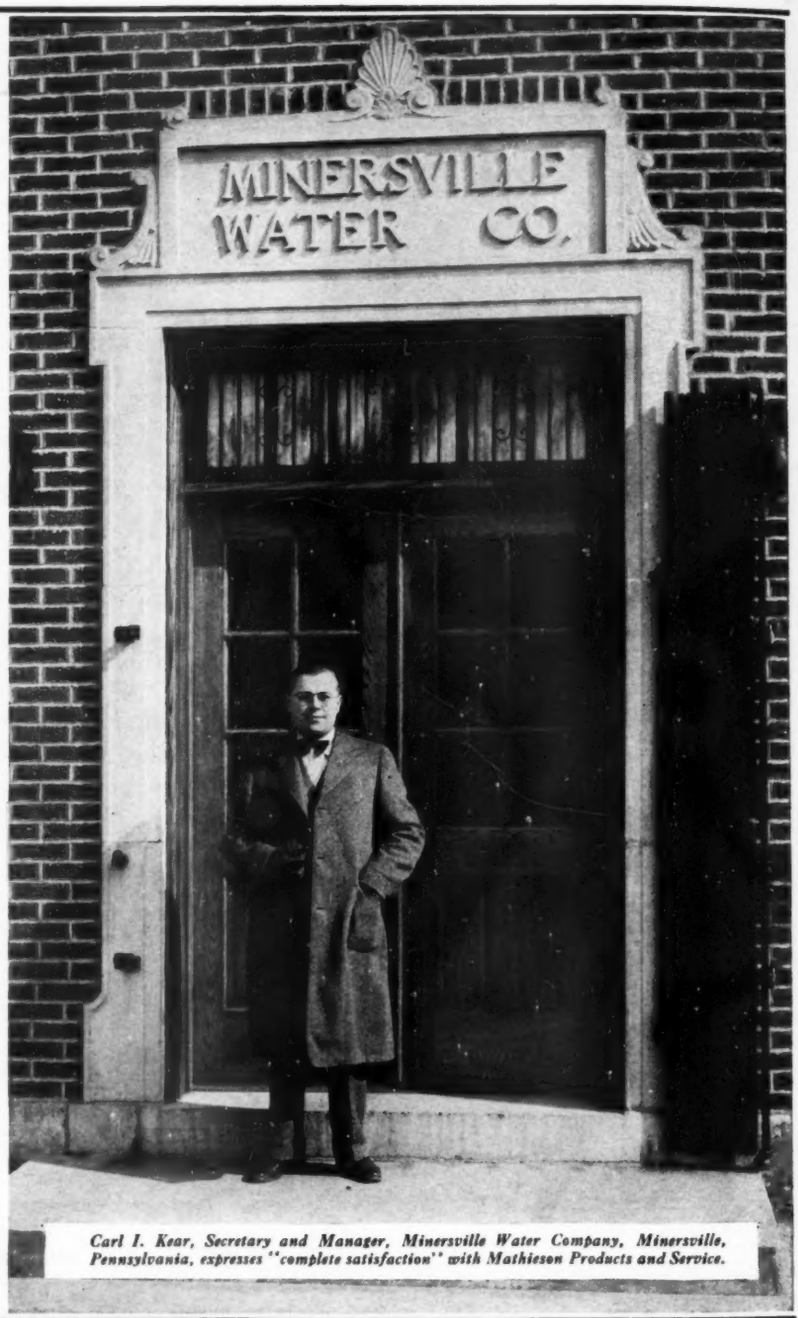
MINERSVILLE WATER COMPANY

Manager

FROM Carl I. Kear, whose letter is reproduced above, comes further evidence that water works men appreciate Mathieson quality and service.

As Mr. Kear says in his letter, "With no standby cylinders for emergency use we would be handicapped if troubled with dirty cylinders or sticking control valves. Thanks to your careful attention to this feature we have had no such difficulty. Our satisfaction is therefore complete."

To such a clear statement of satisfaction, there is little we can add—except that a thorough trial of Mathieson Chlorine and HTH will convince you of their dependability.



Carl I. Kear, Secretary and Manager, Minersville Water Company, Minersville, Pennsylvania, expresses "complete satisfaction" with Mathieson Products and Service.

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Mauufactured by

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WATER WORKS & SEWERAGE

E. S. GILLETTE, Publisher

L. H. ENSLOW, Editor

ARTICLES AND AUTHORS Scheduled for Future Issues

"The Combination Sewage Works of Cedar Rapids, Ia."—Represents the first development of consequence, involving a cooperative effort, wherein the taxing municipality provides industrial waste treatment in a preparatory separate chemical pre-treatment plant, delivering effluent to be "finished off" in its domestic biological treatment works. In his article, briefly describing these pioneering combination works, which serve jointly the industrial and private taxpayer, Howard R. Green, Cedar Rapids' consulting engineer, designer of the plant, discusses the good and bad features of the project. His analysis is amplified with operating experiences, experimental findings, and plant performance records during the first year of operation. This is to be the initial article on an important project, justifying "follower" articles dealing with integral considerations of this new venture, which involves municipal service to industry on an equitable cost basis. The author comments, "Our highest satisfaction comes in the fact that it has not been necessary to nurse the plant along in any department."

"Water Softening Improvements at Topeka, Kansas"—Constitutes a long waited for contribution from Daniel H. Rupp, Production Engineer, who tells of important improvements in process, design and equipment at Topeka's Water Softening Plant, of which he has charge. Improvements that have been made are those considered desirable and warranted, on the basis of operating efficiency and economics, by a chemist-engineer of long experience in water treatment. Mr. Rupp tells the "why" of such improvements, both as to methods and equipment involved; as to performance and accomplishments, both technically and in operating cost reductions attained. Here is an "ace" article from an "ace" operator. It has much of value for the designing as well as the operating engineer.

John D. Watson, eminent British Consulting and Designing Engineer, who has to his recent credit England's outstanding 690 m.g.d. Mogden activated-sludge plant, serving 16 communities in the environs of London, has agreed to become a much sought after contributor of a series of articles for the benefit of our readers. The first of these, dealing with "SEWER FLUSHING," is an analysis of what constitutes good and indifferent methods and their effectiveness, or lack of such, under practical conditions. We feel safe in predicting that, as an authority of long and varied experiences, Dr. Watson's contributions will prove amongst the most valuable that WATER WORKS AND SEWERAGE has ever been in a position to offer its readers. His first article will appear in our next issue.

"MEETINGS SCHEDULED"—Please note that the listings of "Meetings Scheduled" are now located in the fore part of our rear advertising section. For reader convenience, each issue designates the page number in the "Table of Contents" on this page.

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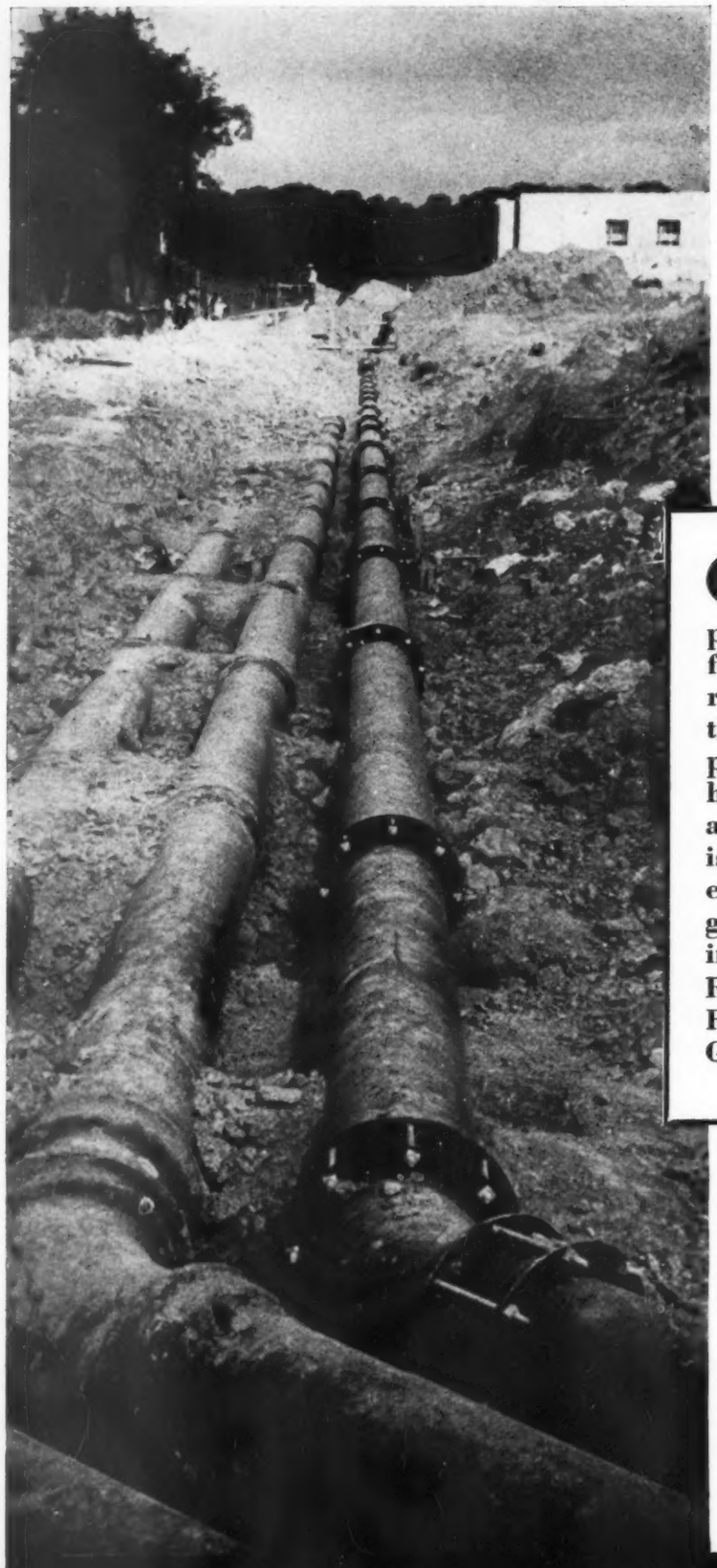


CAST iron pipe, virtually indispensable for treatment and disposal plant construction, is now widely used for sanitary sewers as well. The recent rapid development in plant construction has created a need of infiltration-proof lines. A cast iron sanitary sewer has tight joints that prevent infiltration and keep out tree roots. The line itself is a permanent structure—the material effectively resists corrosion and has great compressive strength. For further information, write The Cast Iron Pipe Research Association, Thos. F. Wolfe, Research Engineer, 1013 Peoples Gas Bldg., Chicago.

Cast iron pipe installed in construction of District of Columbia, Sewage Disposal Plant.

CAST IRON PIPE

WATER WORKS AND SEWERAGE
A GILLETTE PUBLICATION
VOL. 84 JUNE, 1937 No. 6

THE NEW WATER FILTRATION PLANT OF HAMMOND

By LEO BESOZZI

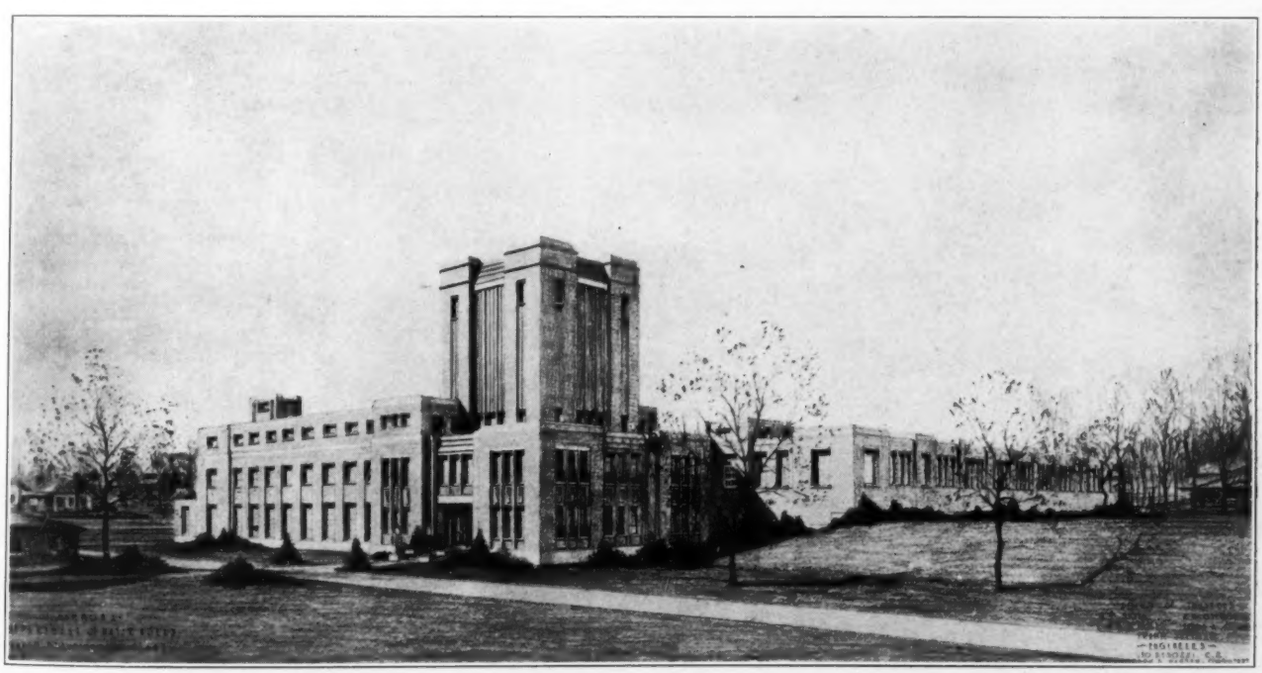
Supervising Engineer
Water Department of Hammond, Ind.

THE City of Hammond, located on Lake Michigan at the extreme northwest corner of the State of Indiana in the "Chicago District" and in the center of the industrial "Calumet Region," has taken its water supply from Lake Michigan for over a period of forty years and for about twenty-five of these years did not in any way treat the water. The Great Lakes constitute one of the world's best natural sources of water supply but unfortunately these great water bodies have been also proved convenient for disposal of sewage and industrial wastes. As the populations of the Calumet Region and the Chicago Districts have increased (and the growth has been an extraordinary one) the marginal waters of the lake have become so seriously and extensively polluted that no city at present time can take water from the lower end of Lake Michigan without providing treatment to make it safe and palatable.

In many instances such as at Milwaukee, Chicago, Cleveland, Toronto, Rochester, Toledo, Detroit, and Buffalo, the treatment of sewage has been undertaken to protect the shore waters of the lake but the cities along the lake in Indiana, because of negligence in this matter, have rendered the marginal waters of Lake Michigan between Chicago and Michigan City, Indiana, more seriously polluted than any other locality in the entire Great Lakes. Especially serious is the pollution by industry.

For fifteen years prior to the construction of the recently completed water filtration plant of Hammond, its public health has been protected by heavy chlorination alone, with applied chlorine doses running at times as high as 7.0 p.p.m. to cope with the chlorine demand created by pollution.

Excessive residual chlorine was maintained and although the water had a disagreeable taste and odor it apparently has not caused any water borne disease. In 1924 an investigation of the pollution of Lake Michigan in this region (published as Public Health Bulletin 170), was instituted by the United States Public Health Service.



Front of the Hammond Plant as Seen by a Pen and Ink Sketcher.

It revealed bacterial counts (Agar 37° C. 24 hrs.) as high as 250,000 and B. Coli counts per 100 cc. as high as 1,000,000 for samples of water taken at the Hammond intake.

The most amazing part of the entire matter is that although complete treatment of the Hammond Water was first seriously advocated over twenty years ago, the people of this modern and progressive city (approximate population 70,000) were content to sit idly by and consume diluted chlorinated sewage and do nothing about it. Although the exhaustive investigation carried on by the Public Health Service did bring about the maintenance of a more rigid chlorine control of the water by the Hammond Water Department, it was not until ten years later that definite steps were taken by this city to secure more adequate treatment of its water supply. History may again repeat itself in this particular instance, for if the Indiana cities of the Calumet Region continue to expand as in the past and continue to pollute Lake Michigan with their wastes, the day when the new Hammond purification plant will be unable to carry the load may not be very far away. At the time of this writing the entire sewage of the city of Whiting and the north part of Hammond (population approximately 20,000) is discharged directly into the lake at a point approximately ¼ mile due east of the principal Hammond intake. Furthermore the major portion of the wastes of the great steel and oil industries, together with the sewage of Gary and East Chicago (population approximately 170,000) enters the lake through the U. S. Ship Canal at a point about three miles east of the Hammond intake, and directly in the vicinity of the East Chicago and Whiting intakes.

Taking Steps to Better the Supply

The first definite steps in the construction of the plant at Hammond consisted of the filing of an application, compiled by the writer, with the Federal Emergency Administration of Public Works for a loan and grant of sufficient amount to provide a modern and complete water treatment plant. The application was granted about three months after it was filed and the Common Council of Hammond immediately took steps to begin the work by appointing (as provided by Chapter 235, Indiana Acts 1933), a Board of Trustees to assume control of the entire water department. This Board immediately organized a complete engineering division within the Water Department, retained the firm of Greeley & Hansen of Chicago, Illinois, to act as consultants to their engineers, employed an attorney and began work.

The first consideration given to the design of the plant was the type of water that had to be treated and the objectionable elements in the water that the plant would have to remove. (It should be mentioned here that doubt had been expressed in the past by competent authorities as to whether or not this water could be successfully treated because of its excessive pollution.) Analyses of the raw water showed the following characteristics:

Color.—Lake Michigan water is essentially free of dissolved color but colored industrial wastes in suspension are frequently found. Large areas of the lake in the vicinity of the intake often showed an oil film on the water. Large patches and streaks of industrial wastes are common, together with floating garbage dumped near the Hammond intakes by boats.

Temperatures.—The temperature of water varies from 32° F. to 82° F.—the maximum temperature being in August.

Turbidity.—The turbidity is relatively low during the greatest portion of the time (approximately 10 p.p.m. or under) but the excessive turbidity occurs during times of on-shore winds. During these periods the turbidity of the water went as high as 250 p.p.m. but still higher turbidities have been noted at other times.

Hardness.—The hardness of the water is fairly constant ranging from 120 to 130 p.p.m. and while softening was considered, it was not deemed justified at this time.

Alkalinity.—The alkalinity of the water is likewise

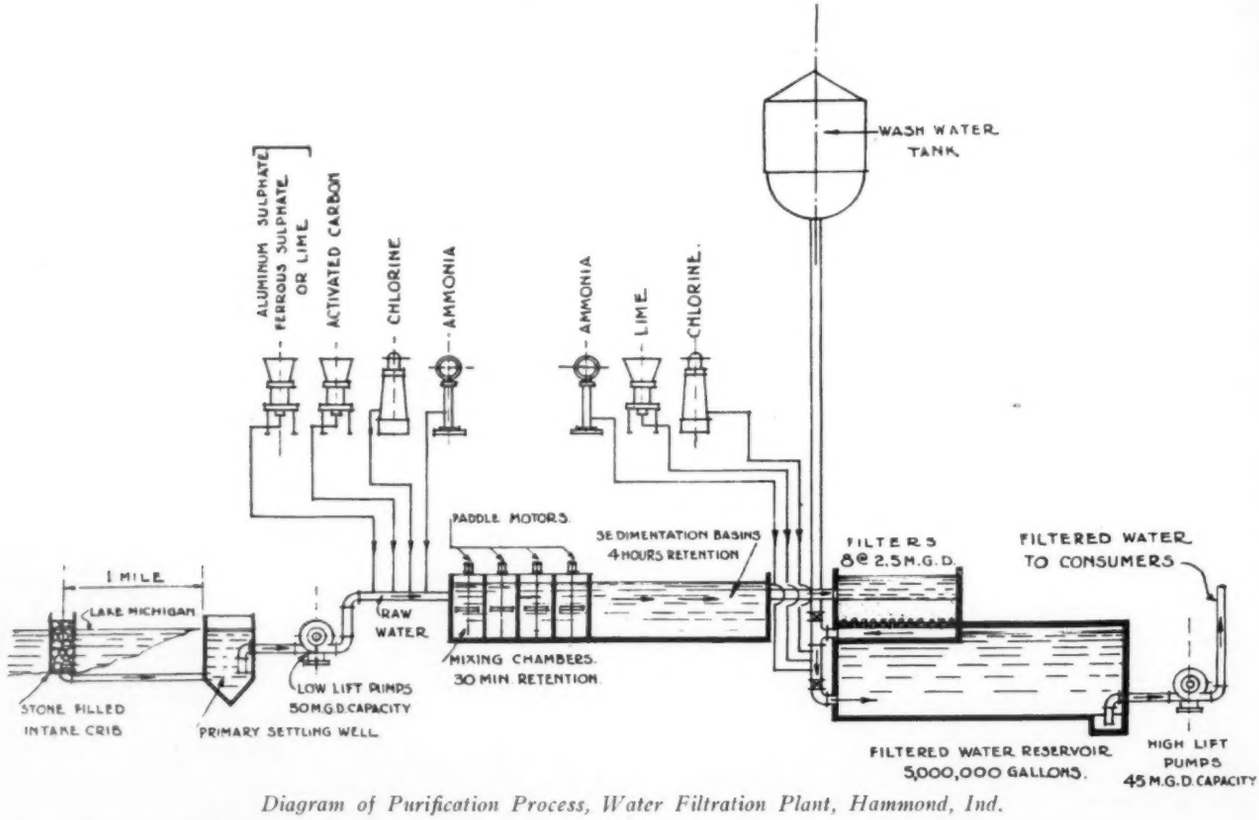
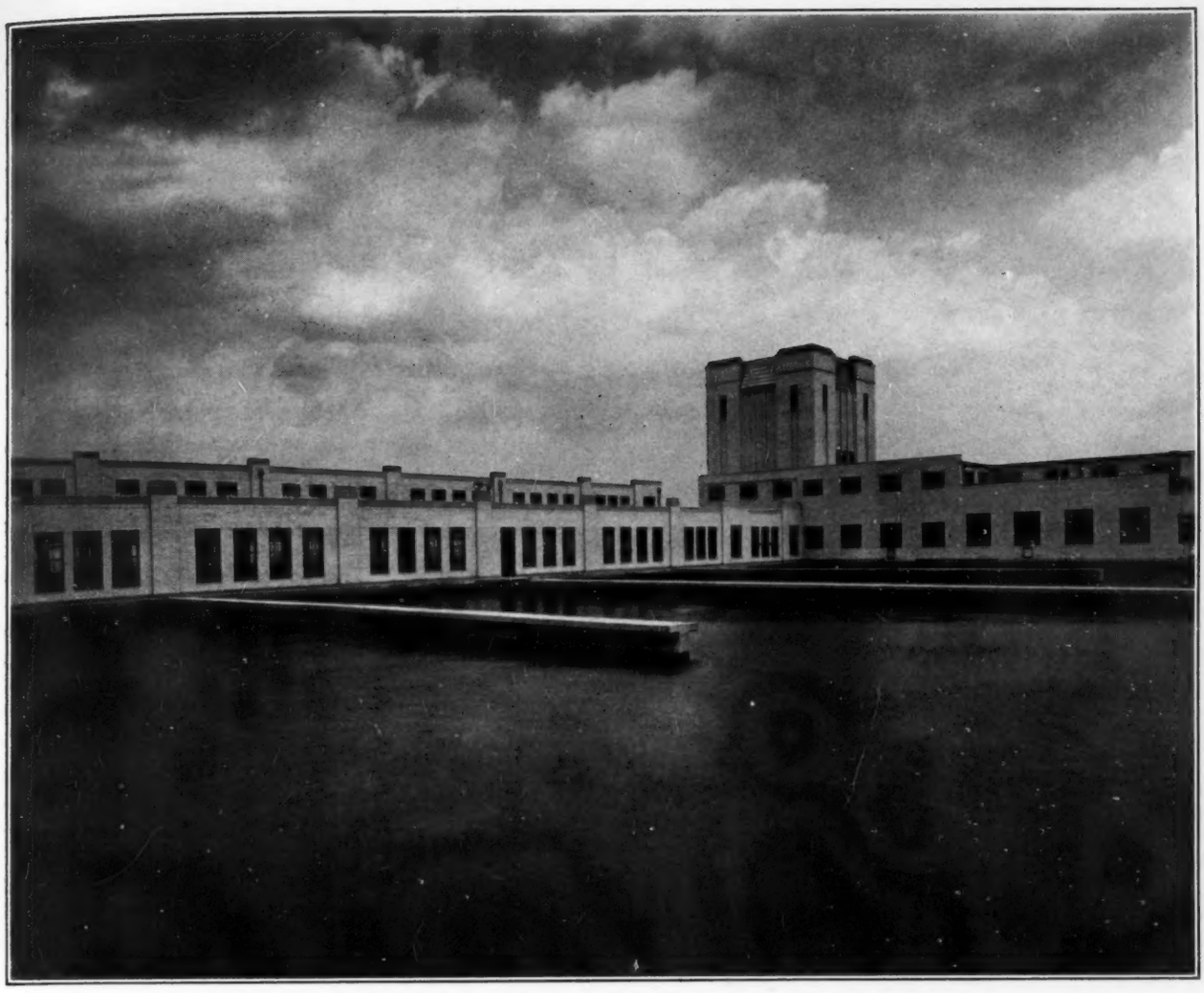


Diagram of Purification Process, Water Filtration Plant, Hammond, Ind.



The New Filtration Plant of Hammond, Ind. (Greeley and Hansen, Engineers).

fairly constant varying from 106 p.p.m. to 117 p.p.m. with a pH of 7.7 to 7.9

Iron and CO_2.—Only traces of these substances are found in the water.

Taste and Odor.—This is perhaps one of the most serious characteristics which the plant would have to combat. Large volumes of industrial wastes, including phenols, oily substances and organic matter, are discharged into the lake in the immediate vicinity of the intakes. The presence of numerous microscopic organisms also indicates that these would be a cause of disagreeable tastes and odors and moreover result in rapid clogging of filters. The threshold odor of the Hammond water varies from 3.0 to about 70 and averages about 25.

Bacteria.—The bacterial content presents a serious problem as has been shown above. It was evident from the start that the plant would have to combat a heavy bacterial pollution resulting from human wastes.

The Plant in Brief

In order to properly treat water with characteristics indicated above it was essential to provide in the design of the plant a wide range of kind and quantity of chemical control and flexibility and accurate control of plant operation. Funds for construction of the plant were limited and it was necessary to keep costs at a minimum.

The design of the plant was based on a capacity of 20 M.G. with necessary provision for operating at 50 per cent overload for limited periods of time. This capacity is based on a study of the past and probable future water requirements of the city and is intended to meet these requirements for a ten year period. Raw water is taken from an existing rock filled timber intake structure located about one mile from the shore of Lake Michigan from which it flows by gravity through the present intakes into an existing intake well located on the shore of the lake. This well is of large dimensions, fits in nicely with the filtration plant, and serves as a sand catcher. The low lift pumps take suction from this well. They are housed in a large pump room built integrally with the filter plant. The water is pumped into a raw water flume and thence flows to eight flocculating chambers arranged in two groups of four each with connections which permit the groups to be operated independently, in series or in parallel. Each chamber is equipped with a vertical variable speed stirring device. The water thence flows into two "around the end" sedimentation basins. From the sedimentation basins the water flows to eight sand filters. The filter effluents enter a main filtered water collector which in turn discharges into the clear water storage reservoir after which it flows through a 42-inch steel pipe to existing high lift steam pumps which deliver the water into the distribution system.

The filter plant proper comprises the following:

(1) Chemical building or headhouse containing raw water pumps, chemical feed and weighing devices, elevated wash water tank, chemical storage space, labora-

tories, offices, shops, locker rooms and other miscellaneous accessories. (2) Raw water flume. (3) Reaction basins. (4) Sedimentation basins. (5) Filters. (6) Pipe gallery. (7) Filtered Water Reservoir.

Included in the project is a steel sheet pile bulkhead approximately 800 feet long to retain an embankment of approximately 60,000 cubic yards of blast furnace slag. This embankment is the "made land" in Lake Michigan upon which the principal parts of the plant are located. A sixteen inch water main approximately 500 feet long across the Grand Calumet River at Calumet Avenue in the City of Hammond, was also constructed as part of the project to insure better distribution of water to the business districts of the city. This main, constructed of the new "Transite" pipe, was suspended from an existing steel and timber bridge across the river at this point.

The capacities of the principal parts of the plant are as follows:

1. Low lift pumping plant in three units—total about 50 M.G.D.
2. Time in reaction basins; 30 minutes at rated capacity.
3. Time in sedimentation basins; 4 hours at rated capacity.
4. Filter beds; 8 units, each with a capacity of 2.5 M.G.D. at a rate of filtration of 2 gallons per square foot per minute.
5. Filtered water reservoir; 5,000,000 gals.

The raw, settled and filtered water conduits, the wash water sewer, the reaction basins, sedimentation basins, filters and reservoir, are constructed of reinforced concrete. All superstructures are of reinforced concrete with brick curtain walls, with the exception of that portion of the chemical building directly beneath, and including the wash water tank tower. This is of steel frame encased in concrete with brick curtain walls. Roofs, with the exception of that over the wash water tank tower, are entirely of reinforced concrete insulated with one-inch of "Celotex" covered with a standard ten year guarantee built-up roof. The roof over the wash water tank tower is of wooden frame covered with copper roofing. Floors throughout are of reinforced concrete covered with composition tile in the entrance lobby, corridors of the headhouse, offices, laboratories and filter house. The remaining floors were hardened and painted. The interior walls of the filter house and low lift pump room are of face brick. The interior walls of the offices, laboratories and chemical feed room are plaster. The interior walls of the entrance lobby and corridors in the headhouse are of terra cotta. All other interior walls are of common brick which are painted in the chlorine and ammonia room and left unpainted in the storage rooms. The exterior walls are of a light buff, hard burned, face brick; Indiana limestone is used for sills, coping and trim.

The entire structure is heated by unit heaters taking steam at reduced pressure from the existing steam high lift pumping station.

Pumps and Meters

Raw water pumping equipment consists of three centrifugal pumps having capacities of 6,950 G.P.M. (10 M.G.D.), 12,500 G.P.M. (18 M.G.D.) and 15,000 G.P.M. (22 M.G.D.) electrically driven by synchronous motors, space being left in the pump room for the addition of a future additional pumping unit. The pumps may be started or stopped from either the floor of the pump room or from a control board located on a balcony seventeen feet above the pump room floor and adjacent to the electrical control room which houses the control panels, lighting and miscellaneous power transformers. Two separate 11,000 volt overhead incoming lines supply the power.

A study of power interruptions for the past ten years indicated that these were infrequent and generally of very short duration, and since the filtered water basin would normally keep the city supplied for a period of at least five hours (this basin is always kept practically full) standby power was omitted in the interests of economy.

The low lift pumps and the wash water pumps are automatically primed by small vacuum pumps but, since the wash water pump takes suction from the filtered water basin and is thereby under head most of the time, its vacuum pump is little used.

An integrating, indicating and recording meter is located on the incoming raw water line. An electrical transmitter for electrical operation of a meter register was provided so that this meter register could be located in the chemical feed room. The high lift pump station was already metered. It was deemed advisable to provide meters for the wash water, the incoming plant water, and the water used by the chemical feed machines so that accurate records of the plant output could be kept.

Chemicals and Feed Equipment

Because of the great variability in the quality of the raw water the plant was designed to permit a maximum of flexibility of operation insofar as this could be accomplished with the funds available; provision being made in the design for convenient future addition of such items as were not immediately required. These items include space for the future addition of two more chemical dry-feed machines, an additional chlorinator and ammoniator, the possible future addition of carbon filters, and the possible future addition of solution feed equipment for feeding ammonium sulphate. The plant was also laid out in a manner to readily provide for the extension of the entire plant. The addition of an electrically operated high lift pump station is readily practicable in event it should become desirable to either replace, electrify or increase the capacity of the existing steam high lift pump station. Even though the possibility of adding an ozone plant is very remote, the plant is so laid out that this also can be accomplished.

Chemicals

The principal coagulant is alum. It may be fed either into the raw water flume or the outlet conduit to the easterly sedimentation basin—the latter to provide for so-called double coagulation. Provision for feeding chlorinated-copperas was also made, the ferrous sulphate (copperas) being fed with chlorine, into a "Transite" pipe mixing chamber where the iron salt is converted into the ferric state and then fed into the raw water at the same points that alum is fed. Lime may be fed in the raw water flume, the outlet conduit to the easterly sedimentation basin or the filtered water collector.

The principal agent provided for removing taste and odor is powdered activated carbon. It may be fed into the raw water flume, the outlet conduit to the easterly sedimentation basin (in case the plant is being operated to provide for double coagulation), reaction basin number 2 and reaction basin number 6 to provide for split feed, and in the settled water collector to provide carbon treatment of the water just before it passes onto the filters.

Chlorine may be fed either to the raw water ahead of the raw water flume, the filtered water collector, and the mixing chamber for producing chlorinated-copperas. Ammonia may be fed to the raw water ahead of the chlorine application and to the filtered water, also ahead of the chlorine application.

Equipment Arrangements

Scales are provided so that all chemicals may be accurately and conveniently weighed and are equipped for the future addition of weight recording devices. Solution tanks are provided for all of the dry feed machines. These are built unusually large in the instance of the carbon machines so that the carbon may be thoroughly wet and mixed in uniform suspension before entering the water to be treated. The solution tanks are made of concrete and are equipped with baffles, water jets and electrically driven stirring devices.

In order to safeguard and to provide for every facility to maintain rigid chemical control in the plant, an unusually well equipped chemical laboratory, preparation room, and bacteriological laboratory were provided in the plant. These laboratories are at present operated by a trained and competent full time analyst.

Separate rooms for feeding and storing carbon were provided to minimize carbon dust about the plant. Separate rooms for feeding chlorine and ammonia were also provided. In case of gas leaks these rooms can be closed off from the rest of the plant and ventilated by mechanical means controlled from the outside.

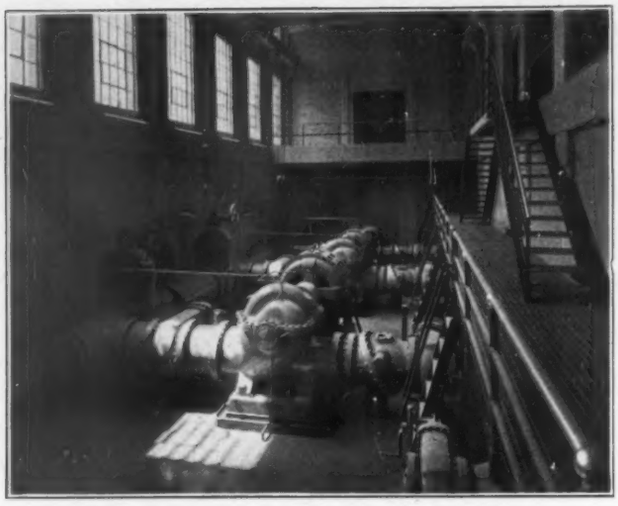
Shades were provided for the windows of the chlorine and ammonia rooms so as to avoid direct sunlight on the containers. The rooms are heated by unit heaters operating by steam, the hot air blasts from the heaters being directed toward the ceiling away from the chlorine and ammonia containers. A hot water line was connected into the feed-water line to the trays of the chlorinators so that this water can be tempered during the winter months.

Chemical Storage

Chemical storage space for dry chemicals was placed on the upper floors of the plant, reached either by stairway or by means of a push button operated freight elevator. Chemicals are fed into hoppers at storage floor level and these in turn discharge into the dry feed machines located on the floor below. By this arrangement the manual labor required for chemical handling is minimized. Pneumatic and mechanical handling of chemicals was considered when the plant was designed but was found to be uneconomical for this particular installation.

Storage space for chlorine and ammonia was provided on the lower floors (same elevation as receiving room floor) and also on the second floor (same elevation as ammonia and chlorine feed room floors) so that cylinders could be kept near the points of use and be handled with a

The Filter Gallery of the Hammond, Ind., Plant. On Left—Flocculating Chamber of 8 Compartments. On Right—Filters, 8 Units of 2.5 M.G.D. Capacity Each



Raw Water Pumps and Balanced Disc Check Valves of the Non-Slam Type.

minimum amount of labor and risk. Chlorine is used at the plant in ton containers and ammonia in the short 150 lb. containers. All chemicals are purchased in carload lots.

Flocculation and Sedimentation

The raw water conduit was constructed to pass through the chemical feed room as an open flume so as to provide convenient inspection of the raw water and enable the operators to detect changes in the quality of the raw water quickly, as well as to provide for visible introduction of chemicals. Nailing strips were left in the sides of the flume to facilitate installing such baffles as may be found desirable during the operation of the plant.

Flocculating Chambers

These receive water from the raw water flume. A somewhat longer displacement period than 30 minutes would have been desirable and would have been provided if there had been sufficient funds available. Each of the eight compartments of the flocculating chambers is provided with a vertical shaft and paddle having two speeds forward, and two speeds reverse. The stirring mechanisms are driven by induction motors designed to operate at speeds of 1720 r.p.m. and 860 r.p.m. by pole changing switch. The motors are mounted directly on speed reducing mechanisms so proportioned as to impart a peripheral speed to the paddles to 3.0 feet per second and 1.5 feet per second. The motors installed are of sufficient capacity to permit the use of additional sets of paddles if such should prove desirable. The flocculating chambers are so arranged and controlled by sluice gates as to permit operation either in parallel, series or for double coagulation. All are located inside the filter house and are provided with walkways and lights to make convenient the observation of the behavior of chemicals added to the water.

Sedimentation Basins

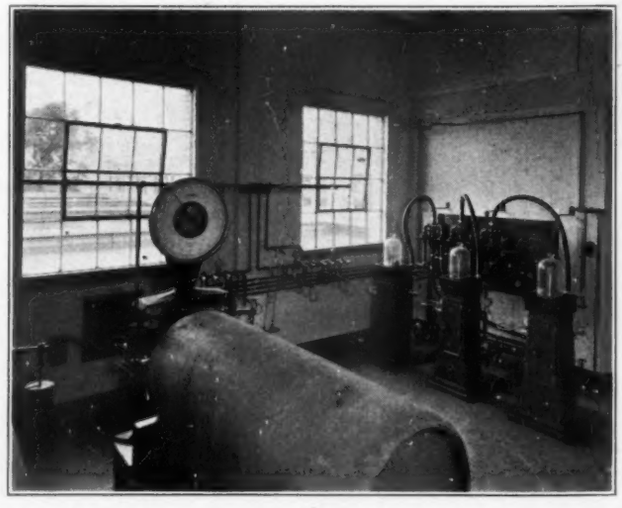
There are two sedimentation basins provided with center baffle having an "around the end" flow. Stop plank grooves are provided at the inlet and the outlet of these basins to permit adjustment of inflow and outflow of the water in order to secure the best sedimentation results in the light of operating experience. The sedimentation basis are located outside the filter house and while they were originally designed as covered basins, they were constructed as open units in the interests of economy. Provisions, however, were made so that the basins can be covered at some future time if this should become necessary or desirable. The displacement period of these basins is four hours at rated plant capacity and while a longer displacement period would have been desirable, it was not provided because of limited funds. The basins are drained by means of a connection to the wash water sewer and are each provided with a six inch water line equipped with fire hose connections in order that they may be periodically cleaned by manually hosing them out. The basins are also provided with flood lights and suitable walkways to provide the operators with convenient observation and sampling points of the water on its course through the basins.

Filters

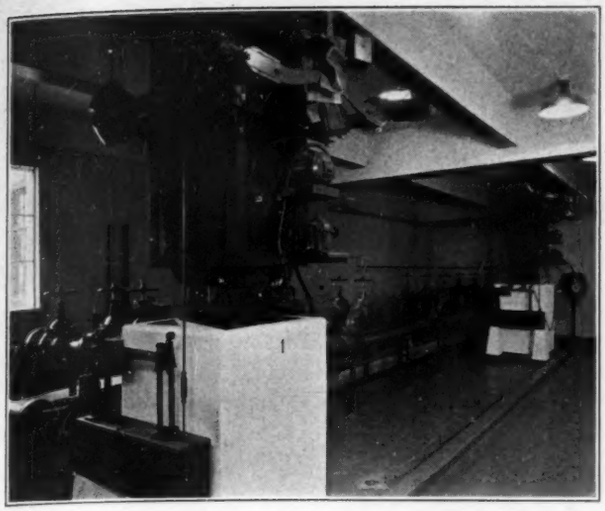
The filters are eight in number, each having a capacity of 2.5 M.G.D. at a 2 gal/sq. ft. rate of filtration. The filters are constructed with a side gutter and steel wash water troughs having adjustable weir plates. The troughs are spaced on 6.0 foot centers. The manifold is 42 inches in diameter and is constructed of reinforced concrete. The lateral pipes are of cast iron, 4 inches in diameter and spaced 12 inches on center. They are connected to cast iron tees which in turn connect with the manifold. The laterals have ½ inch staggered holes (spaced 4¾ inches on centers) drilled on each side 30 degrees off the vertical. The manifold, laterals, troughs, drain to sewer, etc., were designed to permit a back wash rate of 42 inch rise per minute, which is equivalent to approximately 26 gallons per square foot per miunte. The filtering media consists of 18 inches of gravel and 30 inches of sand. The gravel was graded as follows:

		Diameter of Circular Ring in Ins.	
Layer	Depth	Through Which Gravel Will Pass	Through Which Gravel Will Be Retained
1st (bottom)	6	2	1
2nd	4	1	¾
3rd	3	¾	½
4th	3	½	¼
5th	2	¼	Screen 10 meshes per linear inch of No. 20 wire.

The sand used had an effective size of 0.50 to 0.55 of



The Chlorine Room, Thermostat Heat Control of Room and Chlorinator Tray Water.



Portion of Chemical Feeder Room. Machines Suspended on Scales; Raw-Water Flow Indicating and Recording Instruments at Far End of Room.

a millimeter and a uniformity coefficient of approximately 1.6. Both the sand and gravel were tested by immersion in warm concentrated hydrochloric acid for 24 hours and the loss in weight measured. The greatest loss observed in the gravel was 10 per cent and the greatest loss observed in the sand was 3 per cent. A surface wash system for the filters was designed and seriously considered and would have been provided had there been sufficient funds. Wall castings through the filter walls, and space for control valves on the operating tables, however, were provided so that a surface wash system can readily be installed in the future. The filters are provided with influent, effluent, wash water, wash drain, and rewash control (located on marble operating tables in the filter house) together with all necessary instruments for controlling the rate of filtration and measuring and recording rate of flow, loss of head, and rate of back wash. A gauge panel board located at the easterly end of the filter house has located thereon, a recording depth gauge for the filter water basin, a recording depth gauge for the wash water tank, together with a wash water recorder and rate of flow indicator.

Wash Tank and Pipe Gallery

The wash water tank provided is of 100,000 gallons capacity and is located above the headhouse. The tank is enclosed, the brick enclosure walls being an integral part of the headhouse superstructure to form an ornamental tower. The tank is filled by a 3000 G.P.M. wash water pump electrically driven by an induction motor provided for the purpose; or it may be filled as heretofore stated from the high pressure city service. The wash water pump is started and stopped automatically by means of a float switch located on the wash water tank. Provision is made also for manually starting and stopping the pump in order that the draw down in the tank may be measured as a check on the wash water meter.

Mention is made here of the pipe gallery in order to briefly describe the construction of the conduits, piping and control elements. The raw and settled water conduits are both constructed of reinforced concrete as are the filtered water conduit and wash water sewer. The walls of the reaction basins and the filtered water basin form the walls of the pipe gallery. The tops of the filtered water conduit and wash water sewer form the floor of the pipe gallery. These conduits are separated to avoid possibility of pollution of the filtered water, the intervening space being covered with floor grating. All of the remaining piping is of cast iron with the exception of the piping to the hydraulic cylinders of the valves, the operating table manifolds, etc.—these being of "streamlined" copper tubing. All filter control valves are hydraulically operated. All other valves, with the exception of the electrically operated 54-inch valve located on the incoming raw water line and the 42-inch valve located on the outgoing filtered water line, are manually operated, as are all of the sluice gates. There are eight rate controllers (one for each filter) designed to operate within a range of 1 m.g.d. to 3.75 m.g.d. All of the pump check valves have balanced discs and provisions for the future installation of air chambers in the event this is found necessary to prevent slamming.

Filtered Water Reservoir

The filtered water reservoir was originally designed for a capacity of six million gallons, but was reduced to five million gallons to keep within funds available. The filtered water conduit enters the reservoir in a place and manner to direct the water in a circulating path, thus taking advantage of the entire displacement in connection with post chlorination and ammoniation. Three large tightly screened ventilating openings are constructed on the top of the reservoir and one large ventilator is provided in the pipe gallery in the event it should become necessary to seal the openings on the top of the basin to guard against the entrance of fine lake sand or other foreign matter. By maintaining the reservoir one half full, or better, it is possible to operate the existing high lift pumps under positive suction head. Therefore, for this reason and to maintain maximum reserve storage, an attempt is made by the operators to keep the reservoir as full as is practicable. A direct connection suitably valved was also made between the filtered water conduit and the high lift pumps for the purpose of by-passing the reservoir in the event this should become necessary for inspection or cleaning. A glass enclosed and lighted inspection opening into the reservoir is located in the headhouse. A portion of the reservoir underlies and supports the filters by means of beam and slab construction. The balance of the reservoir is of flat slab construction weighted down by earth fill, to resist flotation, because the floor slab of the reservoir is about six feet below mean lake level.

Testing for Materials

To insure strict conformity with the specifications in regard to the quality of materials used in the construction, a commercial testing laboratory was retained to conduct such tests as were required by the engineer's specifications and also by the Engineering Division of the Hammond Water Department.

The materials tested by this laboratory were chiefly cement, sand, stone, structural steel, reinforcing steel, steel for wash water tank, valves, pipe, etc. Crushing tests were made on sample cylinders taken from all concrete placements. The Engineering Division of the Hammond Water Department conducted tests on concrete by means of a field beam breaking apparatus. They also made field tests on sand and gravel grading for concrete aggregates as well as test for moisture, specific gravity, etc., to determine correct proportions for concrete aggregates. Tests were likewise made on filter sand and gravel as previously stated.

A subsoil investigation was conducted to determine

whether or not the subsoil had receded from beneath the slab and footings of the sedimentation basins. A series of holes were drilled through the slab and footings and concrete grout was forced into the holes to refusal. The general results of this revealed that no subsoil settlement had occurred.

Tests were also conducted on all power cables to motors from main line transformers. Acceptance tests were run on all pumps and all important pipe lines were tested under pressure.

Costs

A brief summary of the actual construction costs incurred for the construction of the entire project is set forth in the following table:

Description	Total Cost
16-in. Transite water main suspended from bridge structure across the Grand Calumet River. Approx. 500 ft. long	$ 4,208.02
Blast furnace slag embankment for made land along shore of Lake Michigan to form filtration plant site. Approx. 52,000 cu. yds.	23,985.79
Steel sheet interlocking arch piling bulkhead to retain fill and form short protection work. Approx. 800 ft. long	51,254.75
Filter plant structures	411,112.62
Piping and filter equipment	166,418.71
Filter plant valves	23,618.86
Filter plant sluice gates	5,084.16
Filter plant pumping equipment	12,114.00
Filter plant electrical work	19,449.23
Total contract costs	$717,246.14
Preliminary expense	$ 6,109.21
Lands, easements, etc.	353.53
Engineering	45,858.56
Inspection, supervision and testing materials	24,297.06
Legal, administrative and overhead	7,968.24
Miscellaneous expense	8,599.37
Interest during construction	30,985.55
Grand total	$841,417.66
Cost per million gallons	$ 42,070.88

Acknowledgements

In conclusion the writer takes considerable pleasure in gratefully acknowledging the excellent work of all those connected with the project and particularly the engineers of his staff whose untiring efforts and skill made the plant a reality. The personnel of this force consisted of H. T. Tuinman, A. L. Strode, Otto Keuckels, Ben Seeley, Frank Blocker, Frank Brown, Harry Heck, George Sullivan, Fred Schueman, L. A. Whipple, W. J. Green, Stanley Ibenthal, John Murphy, Norman Brunkow, G. D. Rynertson, and Miss Molly Mitchell.

To members of the consulting engineers staff grateful acknowledgement is made to Mr. Paul Hansen, Mr. L. G. Williams, who served as Resident Engineer, Wm. E. Stanley, J. W. Nemoyer, G. L. Watson and A. C. King.

For assistance in starting the plant thanks are extended to J. C. Vaughn, Chemist, Lloyd Bussert, Chief Operator, and for the many helpful suggestions offered by John R. Baylis of Chicago.

The competent administration of the several Boards of Water Works Trustees headed by Mr. P. T. Smith and the competent work of the executives of the Hammond Water Department headed by Mr. L. C. McCullum and Mr. R. E. Wilhelm, contributed considerably to the success of the project.

The United States Government was well represented by Forrest M. Logan, Donald Graham, Walter Stanton, C. S. Brignall, Murray Herron, Ralph M. Hodnett, and Charles Hill.

Tom Skinker Honored by St. Louis Engineers

Thomas J. Skinker

Thomas J. Skinker, Engineer in Charge of Distribution, St. Louis Water Department, was honored on May 20th by the Engineers' Club of St. Louis, Missouri, by being elected president of the club.

The Engineers' Club of St. Louis is one of the oldest engineering associations in America (1868) and will celebrate its 70th Anniversary with Mr. Skinker as its president. It is also one of the largest — with 880 active members.

To members of the water works fraternity, Tom Skinker needs no introduction. Becoming a member of A.W.W.A. in 1924, he has served since as a member of its Board of Direction and is looked upon as one of the "wheel-horses" and is an important committee worker in the Association. He is also a member of the American Society of Civil Engineers, and for 12 years has been active in the St. Louis Engineers' Club, which on May 20th saw fit to pay honor to whom honor is due.

To the St. Louis Engineers' Club our congratulations on having picked such a live-wire president. And, may we add—that A.W.W.A. with more Tom Skinkers will go far toward the goal set up by its General Policy Committee, for execution by its new energizing Executive Secretary. Yes; say we—*more* Tom Skinkers!

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Ohio Conference on Sewage Treatment Issues 10th Annual Report

The 10th Annual Report of the Ohio Conference on Sewage Treatment (1936) has just been issued. During the depression these printed reports were temporarily suspended, due to lack of funds. Since, however, all delayed reports have been printed and completely financed from the Conference funds, without the former subsidy from the sponsoring Ohio Department of Health. This being the situation, the Reports of the Ohio Conference on Sewage Treatment have been distributed without charge to all members and guests attending the meetings of the Conference and paying a registration fee. A limited number of extra copies have been printed to meet growing outside demands, but must be charged for. However, the price set is barely a cost figure for the 120-page 1936 Proceedings, which contains valuable papers and discussion not available elsewhere.

In the 1936 Proceedings, just out, especially worthy are the several papers and discussions dealing with Trickling Filters—operating and design features; survey statistics revealing their ability to take recorded excessive loadings periodically, etc. In addition, there is a veritable thesis on "Vacuum Filtration of Sewage Sludges"; "Beet Sugar Waste Treatment"; "A Method of Dealing With Sewage Carrying Industrial Wastes Seasonally"; "Round Table—Operator Group Discussions"—of eminently practical value. Copies of the Report of the 1936 Ohio Conference (and possibly earlier issues) can be ordered from the Conference Treasurer—J. H. Wenger, 41 W. Home St., Westerville, Ohio. The price, $1.25 each.

THE MAGNETITE FILTER IN SEWAGE AND WATER TREATMENT

By S. I. ZACK
Sanitary Engineer, Filtration Equipment Corporation, New York, N. Y.

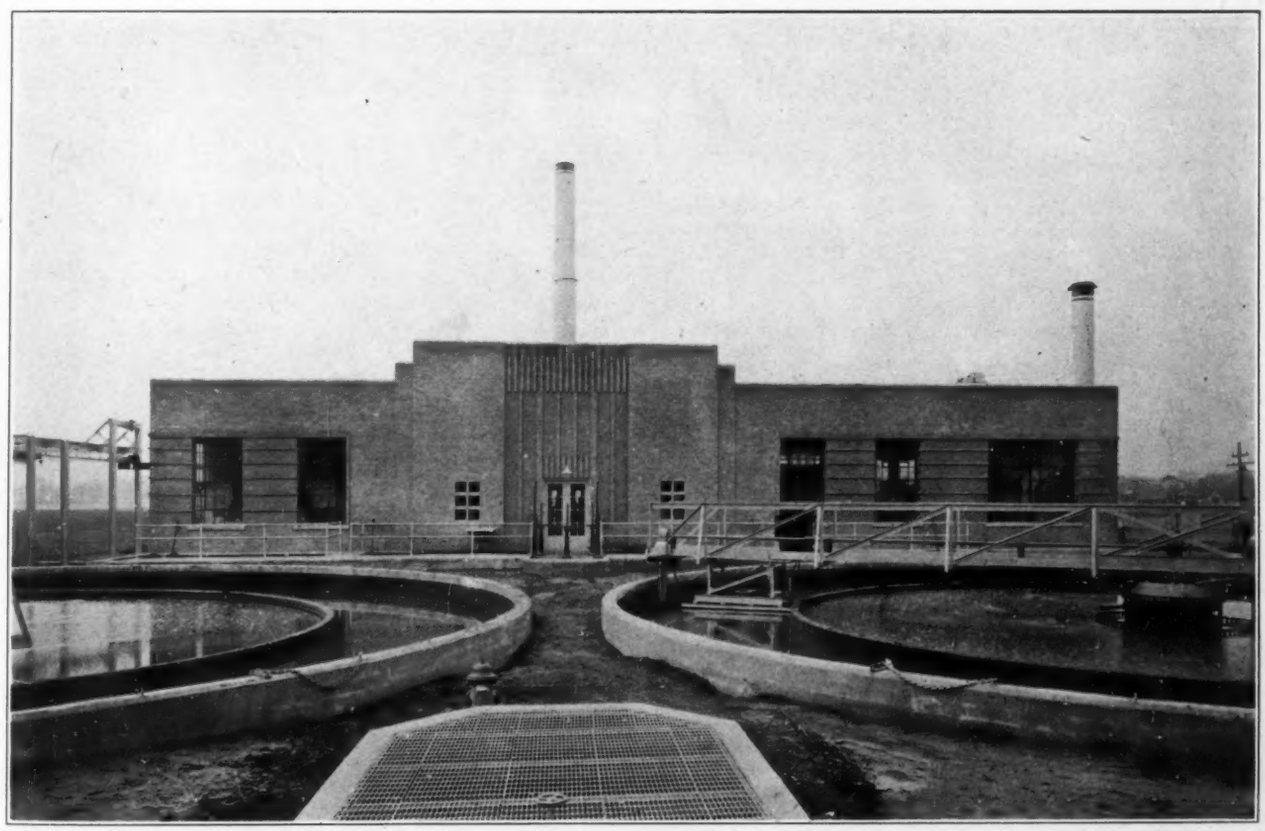
S. I. Zack

THE magnetite filter is essentially an automatically cleaned strainer, effective in the removal of suspended solids, which are otherwise difficult or impossible to take out by sedimentation. It consists of bed of magnetite ore about three inches thick supported on a fine mesh of non-magnetic and corrosion resistant phosphor bronze wire. Fine suspended solids contained in primary or secondary settled effluents are caught between the particles of ore, thereby clarifying these liquors in their passage through the bed. When the interstices between the grains of ore become partly choked with the intercepted solids, the filter is automatically washed by a cleaner which passes slowly over the ore.

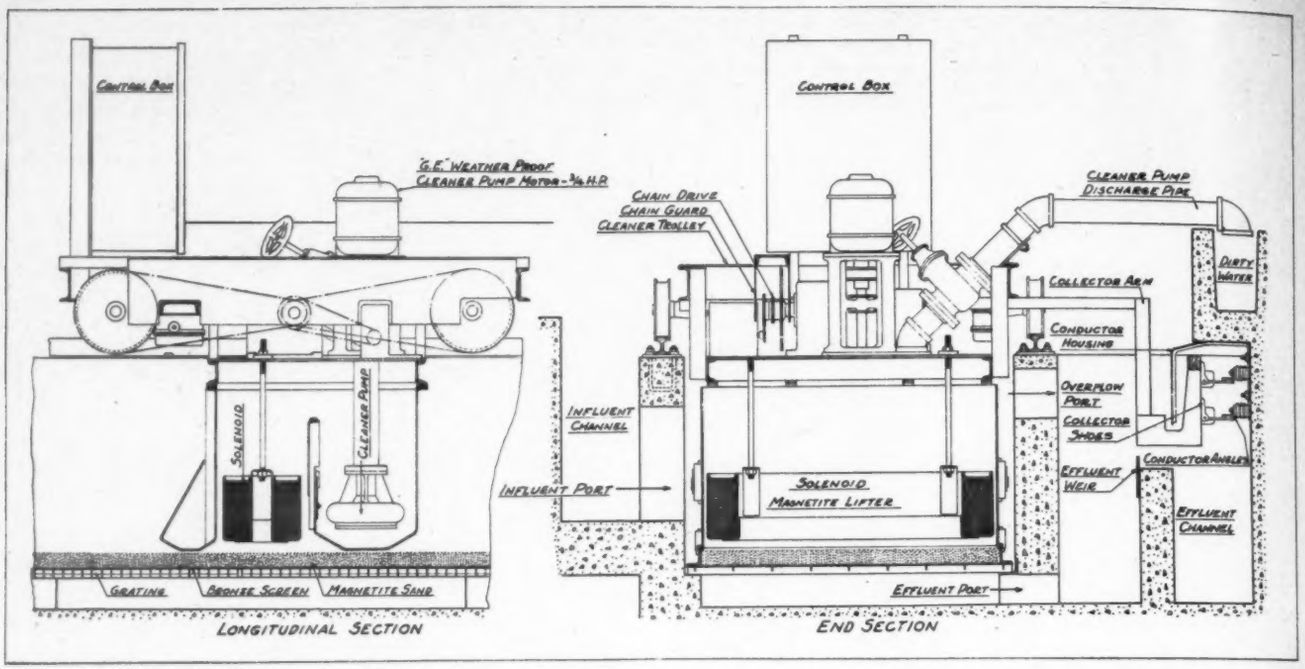
The cleaner consists of a bottomless box or caisson which carries a centrifugal pump, and solenoid or electromagnet. The solenoid is alternately magnetized and demagnetized by interrupted flow of electric current, so that a narrow strip of ore is intermittently lifted off the wire screen and allowed to fall back. At the same time the small centrifugal pump maintains a head level which causes the liquor from beneath the bed to rush through the moving ore and effectively clean the portion of the bed lifted and agitated by the solenoid. The wash water containing the impurities from the ore is caught up by the pump and passed back for retreatment.

This filter is adaptable for upward or downward flow filtration. In upflow it is usually supported on brackets on the inside rim of circular tanks. A number of plants using this type of design are either in operation or under construction. Upflow filters can also be designed for rectangular sedimentation tanks. The downward flow magnetite filter is a somewhat newer development, and was first demonstrated at Coney Island by means of a small circular filter. More recently this principle has been applied to a rectangular arrangement with reversal of the cleaning mechanism. The City of Denver and the Minneapolis-St. Paul Sanitary District are constructing downflow filters in separate rectangular structures.

An upflow filter within a tank provides a uniform distribution of effluent take-off over a large area, thereby retarding upward velocities and defeating short circuit-



The New Elmira (N. Y.) Sewage Treatment Plant—Provides Chemical Precipitation in Twin Magnetite Filter—Equipped Clarifiers; Dewaters Sludge on Vacuum—Filters and Incinerates the Cake.



Drawings of the New Down-Flow Magnetite Filter, Showing Cleaning Mechanism and Details. (See Also Picture of Denver Installation Under Construction.)

ing. Such factors as the following, however, often make the downflow filter a desirable unit:

1. Flexibility of the filtering unit separated from the settler.
2. Size of grain not limited by the practical minimum screen opening as in upflow, because unfiltered liquor first reaches the washable filter medium.
3. Higher efficiency of removal possible with finer grain.
4. Filter medium washed with filtered liquor.
5. Less limitation on maximum loss of head, making possible somewhat higher filter rates.

History of Development

The magnetite filter, developed by W. C. Laughlin, was first used on a large scale at the Dearborn, Michigan Sewage Disposal Plant as an integral and important element in the Laughlin Chemical Treatment Process, the installation of which denoted the return to chemical precipitation of sewage by modernized methods.

This plant was placed in operation in March, 1932. Sewage after coagulation by means of ferric chloride, lime and pulped waste paper, was settled in twin 60 foot diameter clarifiers and filtered upward through the 8 foot wide magnetite filters. Later the use of paper was abandoned. Now the filters are operating as strainers to further polish the settled effluent chemically precipitated with moderate amounts of ferric chloride and lime. About 3 m.g.d. is being filtered through one filter.

The Perth Amboy plant, placed in operation June, 1935, although also constructed for operation with lime, ferric chloride and paper pulp, has not found it necessary to use paper, and only applies chemicals during the summer months. During the fall, winter and spring sufficient treatment is obtained by simply straining the settled effluent. Lime and ferric chloride were used during the summer of 1935 and again during the summer of 1936. For a period of about eight months, from October 1st, 1935, to June, 1936, and during the fall and winter period following no chemicals were used. This plant provided the first large scale operation of the magnetite filter on non-chemically treated effluent. This plant has twin 80 foot diameter clarifiers, each equipped with a 12 foot wide upflow filter. From 3.0 to 5.0 m.g.d. is handled by one clarifier and filter.

A 3 foot wide upflow filter in a 20 foot diameter settler was operated on final activated sludge in a seven months test, June, 1934, to February, 1935, at the North Side Plant of the Sanitary District of Chicago. It was found to be mechanically operative and produced a filtered effluent crystal clear in appearance and practically free from visible suspended solids. It was also evident from the results of this test that the filter would make up deficiencies caused by such factors as reduced or insufficient aeration and final settling.

Comparative tests were made at Coney Island (1934 to 1935) with two tanks in parallel, one without and one with a filter to determine the relative economics and efficiencies of filtration as affecting chemically precipitated and plain settled effluents. Information was obtained from these tests that, for chemical treatment, the filter improved the effluent over that possible by plain tanks, reduced the size of tanks required for settling and effected savings in the chemicals required for precipitation; and in non-chemical treatment improved the quality of effluent and rendered smaller settling units feasible.

The use of magnetite filters as a means of improving the final settled effluents from trickling filters and reducing the size of humus tanks was shown by tests and demonstrations at Atlanta in 1935 by M. F. Singleton, Consulting Engineer.

Tests with a circular downflow filter carried on during 1936 were recently completed at Coney Island. Similar tests are now under way with a small rectangular downflow filter to check the applicability of important features of mechanical design.

Recent Magnetite Filter Installations

The following magnetite filter installations have been recently put in operation or are now under construction:

Upflow Units

Goshen, Indiana, treatment plant has a 6 foot wide upflow filter in a 45 foot diameter circular tank. The filter strains the effluent from primary sedimentation. No chemicals are used for coagulation of sewage. This plant has a design dry weather flow of 1.7 m.g.d.

The Lakeland Institution, Camden, N. J., plant was put in operation about July, 1936. It will be operated with chemical treatment during the summer and plain settling and straining during the winter period. The plant has twin 21 foot diameter clarifiers, each equipped with a 3 foot wide upflow magnetite filter. The filter strains either chemical or non-chemically treated effluents in accordance with the operating season.

The Chillicothe, Ohio, plant, now in operation, has twin 42 foot diameter clarifiers, each equipped with a 5 foot wide upflow magnetite filter. The filter is used to strain plain settled effluent. Design flow reaching the plant will be 3.0 m.g.d. under average conditions and 6.0 m.g.d. under maximum conditions. A required settling time of 3.0 hours was reduced to 2.0 hours when the effluent filter was incorporated in the design submitted to the State Sanitary Engineer.

One 3 foot wide magnetite upflow filter placed on a 21 foot diameter humus tank following a trickling filter, is in operation at Columbus Grove, Ohio, for straining the final settled trickling filter effluent. In this case the detention time in the settler was reduced from the required 1.5 hours to 0.75 hours because of the magnetite filter installation. The flows will range from an average of 0.5 m.g.d. to a maximum of 1.0 m.g.d.

At Atlanta, Georgia, the 12 foot wide magnetite filter on a 100 foot diameter trickling filter humus tank is being installed. As part of the plant remodelling scheme, it is expected that flows up to 12 m.g.d. will be passed through 2 acres of trickling filter settled in the humus tank for a period of 0.75 hours and filtered upward through a magnetite filter. The magnetite filter was taken as a preferred alternate to a second final settling tank to provide twice the detention period.

Elmira, New York, has twin 60 foot diameter clarifiers, each equipped with 8 foot wide upflow magnetite filters, in operation for the purpose of straining chemical precipitated effluent during the summer and non-chemical effluent during the remainder of the year.

The above outlined upflow filters have all been designed for average filter rates of 2.0 and maximum of 3.0 gal. per sq. ft. per min.

Downflow Units of Important Size

Denver, Colorado, is installing six 12 foot wide by 200 foot long downflow magnetite filters in separate structure for filtering the effluent from the clarifiers. During about 5 months of the year the effluent will be chemically treated, whereas the remainder of the year the effluent is to be filtered after settling without chemicals. For this installation the engineers adopted a magnetite grain size of about 0.45 mm. which is finer than the approximately 0.85 mm. magnetite used in the upflow units in previously mentioned plants. Finer magnetite was chosen to provide an additional safeguard in the reuse of the final effluent for irrigation purposes, particularly because it is believed this size of grain with the aid of coagulant will strain out amoeba. Filter rates will be about 2.5 at the average flow of 54 m.g.d. and 4.0 gal, per sq. ft. per min. at the maximum flow of about 80 m.g.d. to be filtered.

Eight rectangular downflow magnetite filters each 16 foot wide by 245 foot long with 0.85 mm. magnetite was adopted by the Minneapolis-St. Paul District, after exhaustive investigation. The filters will be in use during the entire year, only two months or less of which will be on chemically precipitated and settled effluent. At average design flows of 134 m.g.d. the filters will operate on 3.0 gal. per sq. ft. per min. It is expected to take as much as 268 m.g.d. of maximum storm flows through the beds.

The Southerly plant at Cleveland is being remodelled to provide partial activated sludge followed by trickling filters. The partial activated sludge will make possible the increase in capacity of the trickling filters. Three 16 ft. wide by 229 ft. long downflow magnetite filters are being installed to replace the existing humus tanks, but using the concrete walls of the humus tanks for supporting the magnetite filters. Average flows of 40 m.g.d. and maximum flows of 60 m.g.d. will be filtered.

Upflow magnetite filters 4 feet wide are being installed at Greece, N. Y., in each of two final activated sludge settling tanks. The plant is expected to have an average capacity of 1 m.g.d. and maximum of 2.0 m.g.d. By including the magnetite filters in this design, the detention period of mechanical aeration was reduced 20 per cent—i.e., from 10 to 8 hours, with consequent continuous power economy anticipated.

Results Accomplished by Magnetite Filters

Overall removals at Dearborn where chemicals are used all year round, average about 75 per cent of the B.O.D. and 92 per cent of the suspended solids. This is accomplished for an expenditure of less than $5.00 for chemicals per m.g. of sewage treated.

At Perth Amboy, during chemical treatment, overall removals amount to 65 per cent B.O.D. and 92 per cent suspended solids. The chemical cost here is somewhat under $8.00 per m.g. Perth Amboy sewage is very variable in character and much more difficult to treat. In the course of a day pH of raw sewage may vary from 2.0 to 9.0. During non-chemical treatment overall removals of 70 per cent of the suspended solids are obtained. Special samples taken below the filter have indicated 23 per cent removal by the filter and 47 per cent by settling. The ratio of work done by the filter was approximately the same when the sewage was precipitated with chemicals.

In non-chemical tests at Coney Island, it was found 60 per cent removal of suspended solids was obtained by settling one hour, followed by filtering, as compared to 45 per cent removal by settling alone for two hours.

With chemical treatment it was found that $3.00 per m.g. expenditure for chemicals in plain settling tank accomplished the same suspended solids removal as a settling tank with a filter and no chemicals. Ninety per cent removal of suspended solids was obtained with the filter in conjunction with chemical precipitation at a cost of $6.00 per m.g. for chemicals, whereas $12.00 per m.g. was required to obtain the same treatment in a tank without a filter. As to be expected, for the same amount of chemicals a higher degree of treatment was obtained by the tank with a filter.

Rates of 2.0 to 2.5 gal. per sq. ft. per min. gave the best results for continuous operation of upflow filters, with no marked deterioration in the quality of effluent for temporary rates up to about 3 gals. per sq. ft. per min. The filter was found workable at maximum filter rates as high as 6 gals. per sq. ft. Magnetite grain sizes ranging from .4 mm. to 4.0 mm. were tested in a small circular downflow filter. The best effluent containing as low as 30 ppm. suspended solids was obtained with fine magnetite at about 2.0 gals. per sq. ft. per min. As

At Chillicothe, Ohio—Twin Clarifiers, Magnetite Filter Equipped, Feature; Filter Cleaner Travels Independently of Sludge Scraping Mechanism, Being Driven as a Trolley Supplied Current Through Slip-rings at the Center of the Clarifier. This New Scheme Adds Flexibility to Operation of Clarifier Mechanism and Filter Cleaner, Independently.

the grain size or rate of filtering was increased the quality of effluent decreased. Very substantial removals by the filter nevertheless were obtained even with coarse magnetite and high filter rates, providing, of course, the cleaner was kept in operation to wash the bed.

An average reduction in chlorine demand of about 18 per cent was obtained by filtering out about 50 ppm. suspended solids. As much as 20 to 30 per cent reduction was obtained by filtering the settled effluent of stronger sewages. Reduction of the demand by weak sewages and weak settled effluents range from no reduction to 15 per cent, due to filtration.

Magnetite Filter for Water Treatment

Some interesting results have been obtained on the filtration of water from Lake Sebago, Maine, with an experimental magnetite filter. As recounted in a recent issue of WATER WORKS AND SEWERAGE, these tests are being conducted by the Portland Water District under the direction of Mr. Harry U. Fuller, Engineer, and are chiefly for the purpose of determining the efficiency, economics and design basis of a magnetite filter in the removal of algae and amorphous matter.* Several types of experimental pressure filters are also being operated in parallel at the same time, but these results are not included in the substance of this paper.

An upflow magnetite filter 9 ft. 9 in. long by 9 in. wide with 4.5 sq. ft. of effective filtering area was tested. This filter had 3¼ inches of magnetite over the screen. Effective size of grain was 0.56 mm. with a uniformity co-efficient of 1.10. Sixty per cent of the magnetite screened finer than 0.62 mm.

Water was filtered at rates of 4.0 gal. per sq. ft. per min. Loss of head ranged from 3½ inches water depth on a clean bed up to 6½ inches on a dirty one. The cleaner operated automatically for approximately three minutes at one to three hour intervals. Washing was accomplished by the usual method, with water from below the screen, by means of the solenoid and wash water pump. The wash water so used amounted to between 1 and 2 per cent of the water filtered.

Preliminary results obtained are summarized in the following table:

FILTRATION OF LAKE SEBAGO WATER WITH MAGNETITE FILTER

Removals of Micro-Organisms and Amorphous Matter

	Micro-organisms			Amorphous Matter		
Date	Raw	Filtered	Wash Water	Raw	Filtered	Wash Water
July 31 to Aug. 2..	130	40	1900	710	260	3400
Aug. 3.....	120	20	2400	680	150	3700
Aug. 6.....	140	70	....	990	280	....
Aug. 7.....	200	70	1300	440	120	2500
Aug. 8 and 9.....	120	50	2000	430	190	4900
Average	142	50		650	200	
Avg. pct. removal..	65			70		

Further analysis at a rate of 5 gal. per sq. ft. per min. during the period from August 25th to September 8th showed reductions of combined algae and amorphous matter ranging from 66 to 85 per cent.

Oxygen consumed was reduced from an average of 3.4 ppm. to 2.8 by filtering.

Chlorine residual after 30 min. using 1 ppm. was .07 ppm. in unfiltered and 0.28 in filtered on August 3rd and 0.28 in unfiltered and 0.45 in filtered on August 7th.

These results in a preliminary way show the possibilities of filtering raw water with a magnetite filter without the benefit of congulation. Before the experiment is completed it is expected to convert the filter to downflow, and also operate at lower and higher filter rates.

Cost of Magnetite Filters for Sewage Treatment

Size of units, type of installation, whether on settling tanks or in separate structures, all affect the per million gallon cost of magnetite filters. Downflow filters in a separate structure completely installed, having a flow of 10 m.g.d. capacity, would cost about $5,000.00 per m.g.d. capacity. The annual cost including fixed and operating charges would amount to about $1.50 p.m.g. Smaller capacity filters run higher per million gallon and larger capacity would run somewhat less.

The value of an effluent filter must be based on the need of refinement or polish of effluent required compared to that which is possible of accomplishment by primary or secondary tanks alone, to meet the needs

Down-Flow Magnetite Filters Under Construction at Denver's New 60 M.G.D. Treatment Works. Influent Channels and Influent Ports on Left; Safety Overlow Slots Show in Right Wall Near Top and Effluent Ports Below. Cleaning Mechanism (See Drawing for Details) Travels Between These Walls.

*See "The Algae Strainer"—by Harry U. Fuller, WATER WORKS AND SEWERAGE, April, 1937.

of any local situation. Also consideration must be given the cost per ton of impurities removed from the effluent as compared to other known means of doing the same thing. At best, the amount of treatment required for any situation is seldom a clearly defined limit. Mechanical filtration of effluents offer certain advantages which can hardly be determined in terms of value. Such are: appearance, uniformity, positive straining of secondary depositions in receiving bodies of water. Even though tank treatment appears sufficient, the additional treatment and protection obtainable by such filtering often justifies an additional expenditure, providing, however, the increased treatment can be obtained at reasonable cost per ton of impurities removed from the effluent. Where it is desired to accomplish a definite removal of suspended solids by chemical treatment, the filters are self-supporting on the savings of chemicals alone for seasonal chemical treatment for as short a period as three months per year.

Estimates of cost indicate that magnetite filters will remove solids at a lower cost per ton than any other method in the same range of treatment. For example, on a raw sewage containing 200 ppm., 90 per cent of solids can be removed, at a cost of $35.00 per ton, dry solids by the activated sludge method costing $26.00 per m.g. The magnetite filter makes it possible to remove about 15 ppm. more. The cost for removing the additional 15 ppm. is only about $25.00 per ton. A trickling filter costing $26.00 per m.g. removes 85 per cent of the suspended solids, at a cost of $37.00 per ton. Twenty ppm. more is removed by a magnetite filter at a cost of only $18.00 per ton, for the additional removal. Similarly 50 per cent of the suspended solids can be removed by plain sedimentation, at a cost of about $30.00 per ton. The magnetite filter takes out 40 ppm. or 20 per cent more at a cost of $9.00 per ton for the additional suspended solids removal.

Conclusions

1. Magnetite filters are operative on plain settled, chemically precipitated, activated sludge and trickling filter effluents.

2. Rates from 2 to 4 gal. per sq. ft. per min. are workable on downflow fine grained (0.50 mm.) filter beds and 2.5 to 6.0 gal. per sq. ft. per min. on coarse (0.85 mm.) beds when preceded by at least 1.0 hour of settling.

3. Fine grained magnetite (0.28 mm.) remove algae and amorphous matter from water at filter rates of 2.0 to 4.0 gal. per sq. ft. per min.

4. Effluent filters are economical from the standpoint of: positive savings in chemicals to accomplish a definite treatment; to reduce size of tanks; to obtain uniform effluent; to effect improvement in treatment or polish of preliminary or secondary effluents and to prevent secondary deposition of solids in streams, all of which may be difficult or costly to obtain by other methods.

Acknowledgement—The above represents a paper presented before the Rocky Mountain Section of A. W. W. A. and brought up to date by the author for publication.

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NEW WATER WORKS CUT INSURANCE COST—Construction of 26 municipal water works units in Idaho, at a total cost of $1,265,000, will result in reductions in fire insurance rates ranging up to 35 per cent.

Water and Sewage Laboratory Manual

(A Book Review)

"CHEMICAL AND BACTERIAL ANALYSIS OF WATER AND SEWAGE"—A Laboratory Manual. (Second Edition; 228 pages.) Authors: F. R. Theroux, E. F. Eldridge and W. L. Mallman, all of Michigan State College. Publishers, McGraw-Hill Book Co., New York City. Price $2.50.

Serving a highly valuable purpose, the first edition of this book has now been enlarged and revised. This eminently practical manual is devised to give clear and concise directions covering laboratory work for the benefit of water and sewage men whose training in chemistry and biology is limited. This book outlines methods of procedure step-by-step and explains the underlying chemistry and bacteriology involved. To the second edition has been added the sections on bacteriological work. An easy to follow outline form is used, rather than a more literary and less readily understood presentation. The directions are definite and there is no presumption on the part of the authors that the user has had more than a smattering of the sciences involved. Therein, lies its greatest value—something that has always been lacking in "Standard Methods of Water and Sewage Analysis"—produced by and for men trained in chemistry and bacteriology. The use of formulas and typical calculations, in an illustrative manner, is particularly helpful to the operator and investigator not possessing a background in college chemistry and bacteriology. Also, to those "rusty" in either.

Other noteworthy features: The outlined directions for the preparation and standardization of solutions; brief discussions of the chemistry and bacteriology involved in various reactions and tests; recommended methods of sampling; useful and time saving tables of factors needed for conversions and calculations of results.

This manual should be additionally considered as a companion work to the more profound and legally important "Standard Methods of Analysis." This reviewer has observed or worked with many men (knows others) who would have found this Laboratory Manual of high value in their work. We refer to graduate engineers on whom chemistry and bacteriology courses "took" none too well at college; high school graduates, with enough chemistry to make the manual intelligible; graduate chemists, who have had no bacteriological or chemical water analysis experience; trained water and sewage men, whose chemistry and bacteriology have become a bit "rusty."

Notwithstanding vast improvements in the 1936 edition of "Standard Methods," the "Laboratory Manual" of Engineer Theroux, Chemist Eldridge, Bacteriologist Mallman has filled, and will continue to fill a needed place in college and laboratory libraries; a place in the hands of many a worker who dislikes following little understood procedures "rule-of-thumb-wise," or blindly—but, has neither facilities nor time to dig into the reference works liberally cited in "Standard Methods."

[Copies of this Manual may be ordered through WATER WORKS AND SEWERAGE or from the publishers, at $2.50 per copy, subject to a 10 days' examination.—ED.]

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LONG TIME WATER SUPPLY FOR PHILADELPHIA.—Figures showing it would cost Philadelphia from $150,000,000 to $200,000,000 to creat a long-time, upland water supply have been submitted by Dr. Arthur P. Keegan, chairman of the City Council's committee.

TRANSITE WELL PIPE AND SCREENS

By WM. J. LUMBERT

Superintendent of Water
Scituate, Mass.

Wm. J. Lumbert

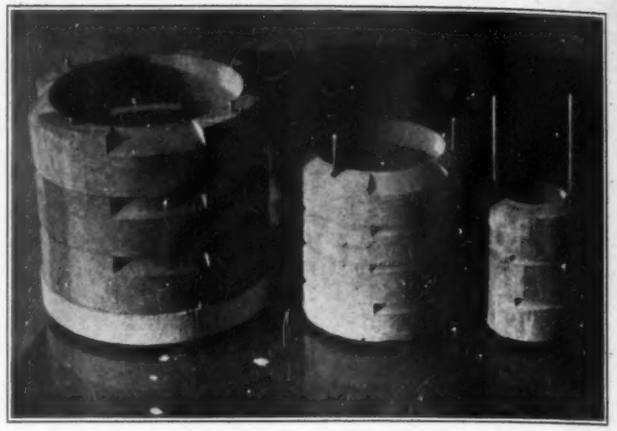
DURING the year 1931, the town of Scituate, Mass., purchased the property of the Scituate Water Co. which was that part of the Community Water Service holdings in the Town of Scituate. The operation of the system was taken over by the Town in July and has been carried on as a publicly owned utility since that time.

The principal source of water supply was the, picturesquely named, Old Oaken Bucket Pond which was inadequate for the peak loads in summer. Due to the necessity of filtration the cost of producing the water was somewhat excessive. New sources of supply were mandatory at once.

Work started by the Community Water Service, consisting of the construction of three deep wells was pushed forward as rapidly as possible. The geological formation in the vicinity of Scituate is such, however, that it is apparently impossible to obtain a sufficient supply of water in any one location. The three wells previously mentioned did not furnish a sufficient supply of water, necessitating continued use of the Old Oaken Bucket Pond. Because the ground water is much more desirable, continued well prospecting has been carried on every year since purchase of the supply, in the search for additional water.

Screen Corrosion a Problem

Iron pipe in sizes from two and one half to thirty inches in diameter has been used in this search and because iron pipe screens which had been in the ground only a few years, were so badly corroded as to require replacement, a more suitable screen and drop-pipe material was sought. After careful consideration of various materials, Transite pipe was selected and is now being used for well screens and well pipe. Transite pipe is manufactured from a mixture of asbestos fibre, Portland cement and powdered silica. It is made up on revolving steel mandrels with a continuous thin sheet of the mixture applied under pressure. The resulting pipe has a dense, homogeneous wall, impervious and not subject to corrosion.



Transite Well Screens

Made Up by Sawing Off Sections of 2, 4 and 6 In. Transite Class C. Pipe. The Tapered Slots (See Drawing) Are Hand Cut and Finished. Sections Held Together by the Protruding Rods of Corrosion Resistant Metal.

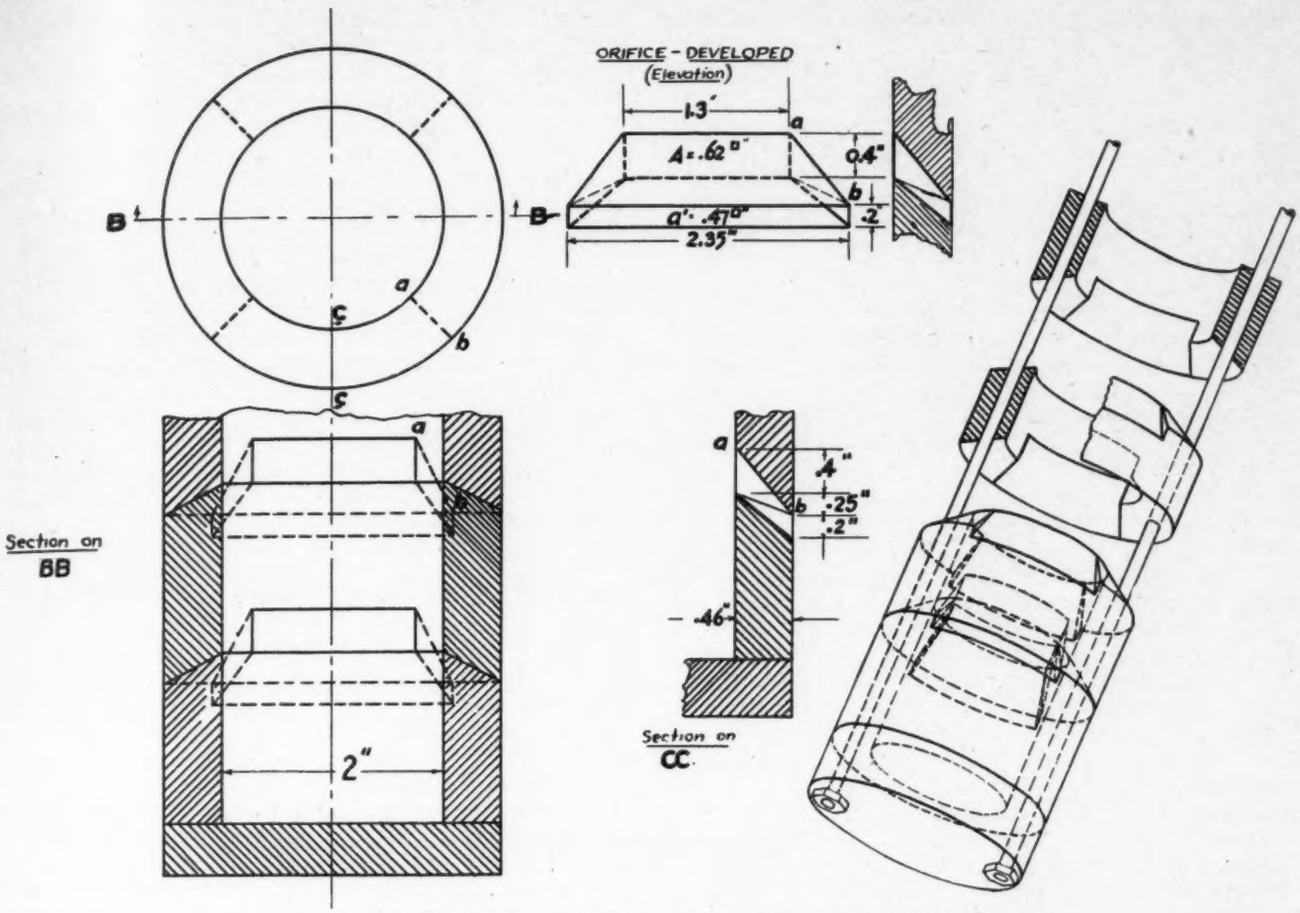
Transite pipe seems particularly suited for well pipe in gravel packed wells and may also be used for the screen. The use of Transite will insure a non-corrosive material for the principal part of the well, and will forever maintain a full flow of water and the need and cost of removing corrosion is precluded.

Experiences in Assembling Transite Well Pipe

In a gravel packed well recently constructed in Scituate, Mass., a sixteen inch Transite pipe was used. The pipe was standard class "C" Transite, sixteen inches inside diameter with a wall thickness of 1.44 inches, each section being thirteen feet long. The weight was approximately 70 pounds per linear foot. The sliding fit Transite couplings (18 inches long), attached to the pipe with Parker Kalon screws, were used to join the lengths together (see picture) as the pipe-string was lowered into

Method of Placing and Jointing Transite Well Pipe

Left—Section of Transite Well Pipe in Place, Ready for the Next. Note Method of Blocking and Collar Held to Pipe by Staggered Rows of Screws. Center—Method of Swinging Lengths of Pipe Into Place. Right—Same Length in Place—Men Are Drilling and Placing Parker Kalon Screws.



Detail Drawing of Well Screen Made Up from Sawed Sections of Transite Pipe.

the well. The total weight of the pipe and screen was approximately 4600 pounds, and using twelve screws on each end of the pipe, the maximum shearing stress was slightly over 380 pounds on each screw. Parker Kalon screws of ⅜ inch wire were placed in two rows, the rows being six inches apart in the top and bottom ends of each coupling, the screws being placed evenly and staggered around pipe. This arrangement placed twelve screws in each end of each pipe, six in each row, and a total of twenty-four in each coupling. The screws were of a length to preclude penetrating the inside surface of the pipe.

Two sets of pipe clamps made of wood (see picture) were used to place the pipe in the well, two thirty foot poles with a crossbar formed the hoist, and a Ford tractor was used for power. One set of clamps was placed on a piece of pipe near one end and a coupling was set on the same end of the pipe. One row of screws was put in to hold the coupling firmly in place. A rope sling was placed over the ends of the clamps below the coupling and the hoisting cable hook passed through the sling.

The pipe was hoisted with the coupling up (see picture), swung over the well and lowered until the clamps rested on timbers laid across the top of the well. The coupling assembly was then completed on that pipe. The next piece of pipe was assembled in the same manner as the first, hoisted over the well and lowered into the coupling on the pipe previously hung in the well. The pipe was carefully set in the coupling and forced home. The upper end of the coupling was then made fast to the upper length of pipe by boring holes with an electric drill and setting the staggered rows of 12 Parker Kalon screws as designed. The pipe assembly in the well was then hoisted to swing free and the lower clamp removed. The pipe was then lowered till the next set of clamps rested on the timbers. This process was repeated until the entire assembly was in the well. The well pipe was then lifted to swing free on the hoist, thus assuring the perpendicularity of the drop pipe. Washed and graded gravel from ⅛ to ⅜ inch in diameter was deposited around the well pipe up to the elevation of the bottom of a concrete seal which was placed later. The cable was then slacked off, allowing the pipe to settle. The settlement was less than ½ inch. This completed the installation of a 16 inch Transite well pipe having a total depth of 60 feet, the entire operation being completed in less than two hours with only three men.

An Unplanned Test

An interesting incident occurred when the coupling which had been placed on the top of the last pipe was removed. This coupling was removed because the grade of the pumphouse floor had been lowered about nine inches. The screws were taken out and two men attempted to lift the 100 pound coupling, but it stuck fast because of the sliding fit. A small wire was then passed through two of the ⅜ inch holes at the top of the coupling and the hoist was hooked on. The coupling again refused to move, but the entire assembly started. The 4600 pounds were suspended on the small cable through the two holes, showing that the shear stress on the double rows of twelve screws was entirely safe. The pipe was allowed to settle (less than one inch) and the coupling was removed, without breakage, by the use of two sixteen pound hammers driving upon the lower edge.

Constructing the Screens

The construction of a Transite well screen may be accomplished in several ways, one of which is detailed in

the accompanying drawing. The sections are made up so that the top of one section fits securely into the bottom of the one next above, and all the sections are drilled with vertical holes so that they may be threaded on rods and properly held in place while being set in the well. The openings are made to fit the conditions found in the water bearing strata or the gravel which is placed around the screen and also are governed somewhat by the amount of water to be drawn from the well. The opening is shaped so that the orificial area on the outside of the pipe is longer and not as wide as the area on the inside of the pipe. This construction allows gravel that may be drawn through the narrow outside area to pass through the screen wall and drop to the bottom instead of being held in the opening and clogging the screen. In the smaller sizes it may be more feasible to bore holes through the shell of the pipe. These holes may be from ¼ to ⅜ inch diameter, sloping upward toward the inside of the pipe. The sloping hole has an effect similar to the shutter type screen, allowing the sand to drop back on the outside of the pipe.

If the screen is on a suction line it is necessary to use the Transite couplings with the rubber ring rather than the slip fit coupling, which is used in the well where the pump is set inside of the screen. Parker Kalon screws (or similar arrangement) become necessary to stiffen the joint and also to take care of the tension while the screen and pipe are being lowered and set in the well. The screws must necessarily be placed near the ends of the coupling, beyond the rubber rings, in order to maintain a vacuum and they must not penetrate the pipe wall.

As in the shutter type of screen the size of the opening would be regulated by the formation of the strata or the gravel used, and in general the total area of the openings, per linear foot of screen would be equal to ⅓ of the area of the inside of the pipe as a minimum. The installation of Transite well pipe and screen offers no more difficulties than other types of screen or pipe, but the inherent properties and nature of Transite require a thorough study of the methods of handling and placing, and in many instances the work is actually simplified to a considerable extent.

For small wells, not over 75 ft. deep, the maximum vacuum that may be safely used on Transite with regular couplings should not exceed 23 inch of mercury. This, however, is beyond the point of efficient operation of pumps in general and allows a reasonable factor of safety.

The strength and feasibility of Transite well pipe and screen was subject to test recently, when we had to pull a six inch screen that had been set forty-two feet deep. The gravel packing was all in place and the iron casting had been pulled. The pipe and screen were pulled through the gravel and disjointed without mishap or damage.

Concerning Sizes of Hole and Casing

The wall thickness of Transite pipe is much greater than that of ordinary metallic pipe and it is therefore necessary to make proper allowance for this factor when designing the well.

Two inch pipe has a wall 0.41 inch thick and the outside diameter of the coupling is 4.6 inches. In order to set a two inch Transite screen the casing used must be at least 6.0 inches, inside diameter. A larger casing will afford more ease in setting the screen and also more space for gravel packing.

Six inch pipe has a wall thickness of 0.68 and the outside diameter at the coupling (using a sliding fit coupling to obtain the minimum diameter), is 8.6 inches. This means that the minimum diameter of the casing in which practical work can be carried on easily and accurately must be not less than 12 inches.

The diameter of the casing used to construct a well in which a sixteen inch Transite pipe and screen was set, was 40 inches at the bottom. The wall thickness of the pipe was 1.44 inches and the outside diameter of the coupling was 22.4 inches, leaving an annular space 8.8 inches for gravel packing. This casing should have been larger.

A 24 inch well screen should have at least a 60 inch casing which will allow an annular space of about 12 inches for gravel. Inasmuch as the amount of gravel that is placed around a well screen is a direct factor affecting the capacity of the well, it is advantageous to use the largest casing practicable.

[*Acknowledgment*: The author has prepared this paper for WATER WORKS AND SEWERAGE, based on notes used in delivering an illustrated talk on the same topic before the March meeting of the New England Water Works Association.—Editor.]

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Don't Miss the Pennsylvania Conferences

At Pennsylvania State College June 21-23 will be held the annual meeting of the Pennsylvania Sewage Works Association. Contiguously, on June 23-25 the meeting of the Pennsylvania Water Operators Association. To this ideal spot—conducive to attention to class room work, good fellowship and college-spirit, recreation (golf and fishing between meetings) and relaxation on a restful campus—those who have attended one of Pennsylvania's conferences at State College will need no urging to attend in June. Those who have not, have been missing something worth while—namely, a taste of a vacation and two technical meetings rolled into one. What's more, with a room in the new dormitories and meals in the college cafe, this makes the week an unusually economical one.

Lack of space prevents going into the two programs, but as usual they will both uphold the reputation of these meetings for interesting papers and discussion. On the opening night of the Sewage Conference (yes, there are night sessions, too) Professor Lewis Carpenter will discuss "Things the Operator Should Know." Later a "Sewage Clinic" is scheduled to occupy an entire afternoon and an always interesting "Gadget Contest" is arranged. A copy of the Water Conference program is not at hand at this writing, but it's bound to be good—always is. So—we say, come to State College if you can possibly arrange it. These conferences have become an institution.

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Gale Dixon Becomes Chief Flood Control Engineer

G. Gale Dixon, former consulting engineer of Youngstown, Ohio, and until recently connected with the Tennessee Valley Authority as an expert on dam foundations and construction, has been appointed Chief Head Control Engineer for the Pennsylvania Water and Power Resources Board, with headquarters in the Arcade building, Harrisburg, Pa.

In the design and construction of the Youngstown water supply and purification works project, Mr. Dixon had an important part. Likewise, in the more recent flood control works on several Ohio streams. He has long been a prominent member of A. W. W. A. and has actively served on several of its committees as chairman or member.

Making Up the Pipe Line on the Assembly and Launching Chute. Three of the Completed Flexible Ball-Joints Are Clearly Visible

THE CROSSING OF TREACHEROUS JOHN'S PASS, FLA.

How a Difficult Problem was Successfully Solved With Cast Iron Pipe Equipped with Improved Ball-Type Joints

By S. K. KELLER*

Clearwater, Florida

PINELLAS County Florida, has the distinction of being one of the very few counties in the United States which owns and operates its water works system. The Pinellas County System serves mainly a seventeen mile long series of Islands (Keys) in the Gulf of Mexico, near St. Petersburg, which parallel the west coast of the county.

The system is a P.W.A. financed project, and consists of a combined surface and shallow well supply located on the mainland near Walsingham, Fla. From here the raw water is pumped to the main treating and pumping plant located near Indian Rocks Beach, Fla. From the treatment plant the purified water is pumped to storage tanks, located on the islands.

The nature of the terrain through which the pipe lines pass from one island to another, has presented several unusual problems in submarine pipe installations, the most important of these being the difficult John's Pass submarine crossing.

John's Pass is one of the main inlets from the Gulf of Mexico to Boca Ciega Bay, which lies between the islands and the mainland. To local navigators it has long been known as one of the most dangerous and

*Resident Engineer for Pinellas County, Florida.

The Crossing of John's Pass, Florida: Floating the 10-Inch Line Across Between Anchor Piling and Temporary Wood Piles. This View from the Center of the Highway Bridge

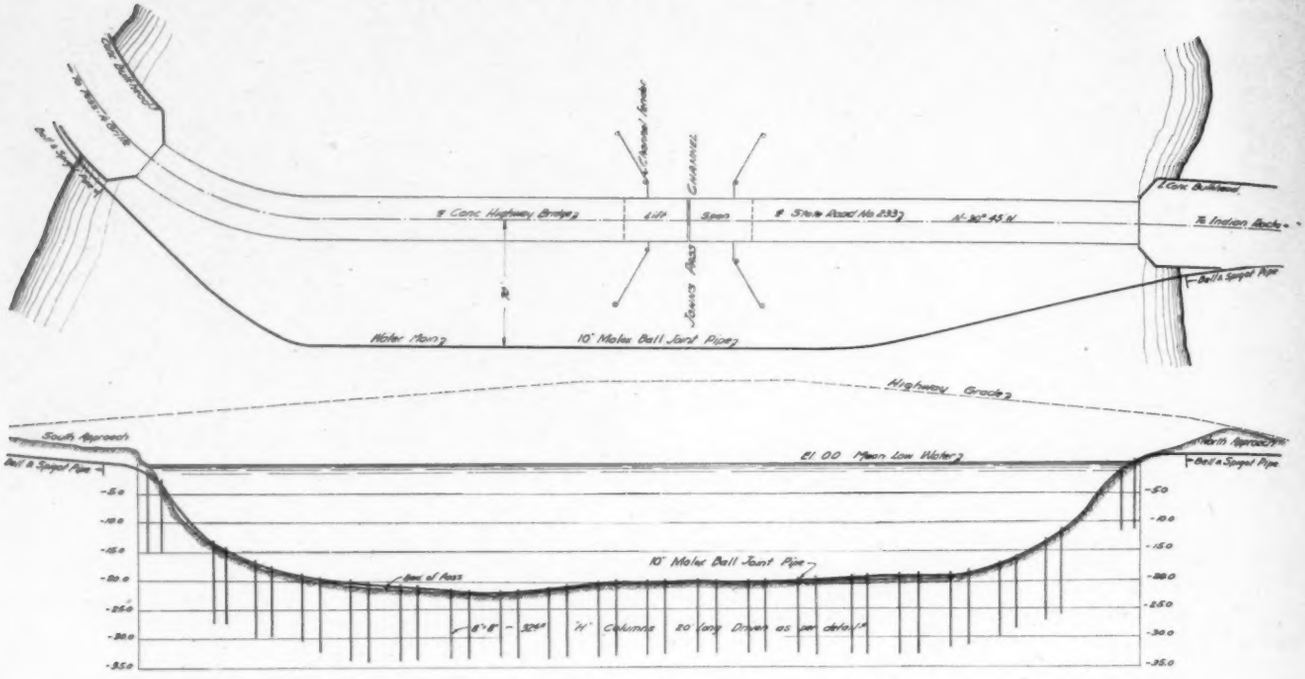

Fig. I.—Plan (above) and Profile (below) of 815 Ft. Pipe Line Crossing of John's Pass on Florida's West Coast

treacherous passes on this coast. It is approximately eight hundred feet wide and approximately twenty-three feet deep at the site of the pipe line crossing. During incoming and outgoing tides, the current which maintains a rate of flow from five to seven miles per hour, is a swirling and eddying tidal water, in which the channel is constantly shifting in location.

The pipe line at this point parallels a concrete highway bridge, having a draw span in the center. An

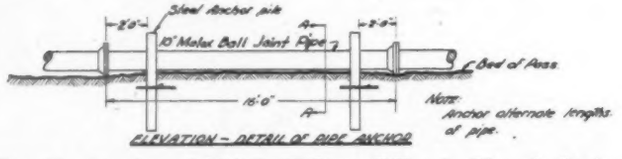
Steel Anchor pile
10' Molex Ball Joint Pipe
Bed of Pass
Note: Anchor alternate lengths of pipe.
ELEVATION - DETAIL OF PIPE ANCHOR

Fig. II.—Spacing of 32.6 lb. H-Beam Piling in Pipe Anchoring, John's Pass, Fla. (See Also Figs. III and IV for Details)

examination into the records of the County Highway Department proved this bridge had given considerable trouble in the past, in which heavy repairs were necessitated by reason of washouts and undermining of the foundations, caused by the swift and changing currents. This condition, coupled with the fact that a draw span had to be maintained for marine traffic, brought about the decision to construct a separate pipe line crossing, entirely removed from the bridge, and to depend on a system of anchors to hold the pipe in place on the bed of the pass. A location for the crossing was therefore selected on the inland side of the bridge about seventy feet from the center, as is shown in Fig. I and in a picture taken from the bridge.

A series of anchors was then designed as shown in Fig. II and located as shown on the profile of the line crossing—(Fig. I). These anchors consisted of eight-inch steel 32.6 lb. "H" beams, a minimum of twenty feet long. These piles were drilled as sketched and driven to practically full penetration in the bed of the pass, with only the head projecting above the bottom, so that when the pipe was installed it would rest directly upon the bottom as well as be anchored to the piling—Fig. II. The anchoring was then completed (Figs. III and IV) by means of galvanized cable and bolts.

In selecting the pipe and method of jointing, various types of flexible joints were considered. After careful analysis and consultation, with the contractor Molox Ball-Joint Pipe (manufactured by the American Cast Iron Pipe Company) was selected as possessing features which made it especially suitable for this crossing. Since we considered the flexibility of the line such an important feature it may serve a useful purpose to describe the joint in some detail.

Description of Pipe Used

The pipes were manufactured at Birmingham, Ala., in 16-foot lengths by the slow cooling Mono-Cast centrifugal method and then equipped with the Molox Ball-Joint. This mechanical joint, has an approximate deflection of 15 degrees; and it was this feature which made the pipe especially attractive for the job at hand, involving submarine laying in the difficult spot already described.

As pictured in the accompanying drawing (Fig. V), supplied by the manufacturer, one end of each 16-foot length of pipe is provided with a spherical socket and a flange. The other end is provided with a square bead on the spigot. In making up the joint, a solid cast iron

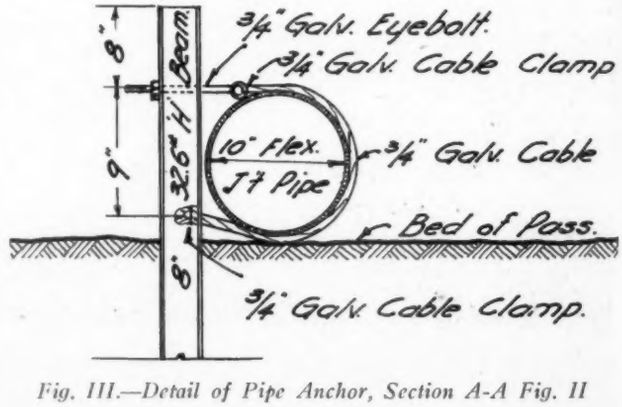

Fig. III.—Detail of Pipe Anchor, Section A-A Fig. II

retainer ring (broken at one place) is stretched over the bead on the spigot to form a seat for a gasket of rubber, which is duck-tipped. A split cast iron gland-lip is next placed on the spigot end of the pipe and the two halves are keyed together. This gland-lip has a ball or spherical outside surface which engages the spherical inside surface of the gland. The spigot end of the pipe, when assembled, then has a spherical surface which properly fits and slides in the spherical socket and inside surface of the gland.

The gland is telescoped to enclose the socket flange when the joint is tight. This telescoping feature not only protects the bolt against corrosion, but also precludes shearing or bending stresses, even when the joint has deflected to its maximum position. The cast iron retainer ring, in the socket, and the spigot end of the pipe is free to move longitudinally through the retainer ring between the limits of the clearance at the bottom of the socket and the shoulder of the spigot bead. This type of joint therefore allows a degree of expansion and contraction; but, at the same time, is positively locked against final joint separation.

The pipe, as received on the job, had the jointing parts already assembled in place and protected with burlap wrapping; it was only necessary to clean and lubricate the joint surfaces and connect the lengths by drawing up the bolts, as pictured in an accompanying photograph.

Construction Procedure

The contractors and engineer carefully studied existing conditions, and a complete outline of methods to be employed in the installation of this line was made before any actual work was started. As a result, it was not found necessary to deviate from the original plan at any point during the installation.

The steel piles were purchased an average of forty feet long, instead of the twenty feet in length as originally specified. These were then driven to exact final location and grade across the pass, using a heavy floating driver equipped with a steam hammer. The excess length of the piling, which projected above mean low water, served as the needed temporary guide and support piling for the pipe line. Then a line of temporary pine piling was driven a distance of six feet from the line of the steel piling, as may be seen in an accompanying photograph. A wood runway or ramp was constructed on the north bank of the pass, extending from dry land to a point below low water, where the pipe line could be floated at the end of the runway. This provided a working space for coupling pipe together and a chute over which the pipe line could be slid into the water.

The pipe joints were made up on the ramp. The forward end of the first pipe was sealed with a plug. As the joints were completed the pipe line was moved down the ramp and into the water by means of hand-operated winch, anchored to a dead man. The pipe line was floated between the rows of piling by attaching three empty oil drums to each length of pipe.

Stringing the pipe line scross the pass in this fashion was the most difficult phase of the entire project, because very little headway could be made except at flood

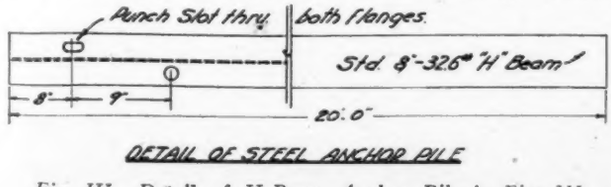

Fig. IV.—Detail of H-Beam Anchor Pile in Fig. III

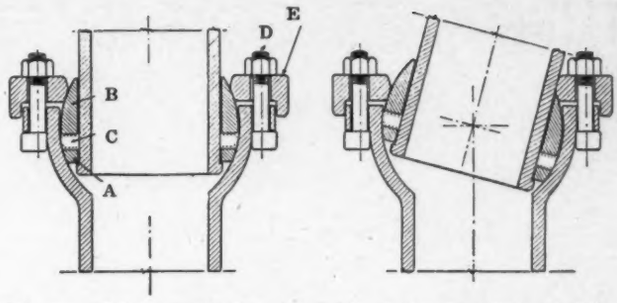

Fig. V.—Molox Ball-Joint Assembly. (A) Cast Iron Retainer Ring; (B) Split Cast Iron Gland Ring; (C) Rubber Ring Gasket (Duck Tipped); (D) Corrosion Resistant Hoe Head Bolts; (E) Cast Steel Gland. (Drawing by Courtesy Am. Cast Iron Pipe Co.)

and ebb tide. During the periods of incoming and outgoing tides the speed of the current was so great that the floating pipe line could not be controlled sufficiently to insure safe forward movement. Despite these difficulties, the pipe line was floated the entire eight hundred feet across the pass from the north to the south bank, where it was landed and connected to the end of the shore main which had previously been constructed.

Excellent Progress Made

The total time required for this operation was seven days, which is considered excellent progress in view of delays caused by tidal conditions and the necessity of keeping the channel open for light draft vessels.

Beginning at the southerly end, the pipe line was then gradually lowered to the bed of the pass. This was accomplished by first filling the line with water, then removing one-third of the oil drums, followed by the removal of another third of the drums. The pipe line then settled into final position adjacent to the steel anchor piling and was fastened thereto (using the scheme detailed in Figs. III and IV) by divers using a full diving outfit. The installation was completed from the south to the north bank, and connection was made to the shore main at that point.

The divers then cut-off the steel piling under water immediately above the pipe line as shown in Fig. III, using an acetylene torch. The installation completed, the temporary wood piling was pulled.

Line Test for Leakage

The line was tested after completion, at one hundred and twenty (120) pounds per square inch water pressure, over a twenty-four hour period. No appreciable leakage at the ball-joints or loss of pressure could be detected during the test period and the installation appears to be a success in every way.

The entire installation required twenty-two days from the time of the arrival of the floating equipment until the final test was made. The work was carried out as planned at a cost of $12,250 for the channel crossing. That there were no accidents, or a personal injury of any nature to any of the employees engaged on this rather hazardous undertaking, is considered most gratifying.

The general contractor was The Boyce Company of Clearwater, Fla. Pile driving and submarine diving was done by the Bay Dredging and Construction Company of Tampa, Fla. The pipe, equipped with the ball-joints, was supplied by the American Cast Iron Pipe Co. of Birmingham, Ala. J. F. Reynolds of Jacksonville, Fla., was the Consulting Engineer. The work was under the immediate direction of the writer.

TUBERCULATION IN REVERSE

Is Uncoating of Pipes a Part of the Problem of Corrosion Correction by Treatment?

By I. M. GLACE

Consulting Engineer,
Harrisburg, Pa.

THAT the control of corrosion of pipe lines has not yet been fully solved is evidenced by the character of the papers recently appearing in technical journals on this important phase of water works operation. We refer particularly to the articles of C. B. Hoover (1) on "The Corrosive Action of Various Types of Water on Household Plumbing," and of Powell and Bacon (2) on "Corrosion Control by Deæration" both of which appeared in recent issues of WATER WORKS AND SEWERAGE. It is also noteworthy that the American Water Works Association conducted another symposium on this subject at its 1937 meeting. Other interesting developments have been contributed by Hodges and Ackerman (3) (11) on chloramine treatment for maintaining main carrying capacities; by Hutton (4) on the principles involved in this process; by Ryon (5), and later Glace (6), on the use of marble filters and limestone contact beds; by McLaughlin's (7) presentation of a method for determining calcium carbonate equilibrium in corrosion control. Finally, we have had the comprehensive report of the Committee of the New England Water Works Association on Pipe Line Co-efficients, which includes a discussion on the effects of "Quality of Supply." (See Jour. N. E. W. W. A., September, 1935, for the complete report, a digest of which appears in the Reference and Data Section of WATER WORKS AND SEWERAGE—May, 1936, and May, 1937.—Ed.)

Certain principles or observations set forth in this latter report seem to be worth quoting here:

"Water saturated with calcium carbonate is relatively non-corrosive to iron."

"Corrosive waters are not saturated with calcium carbonate."

"Practically no soluble iron will exist in water saturated with calcium carbonate."

The report also states:

"Hard water with high carbonate content can contain fairly high amounts of CO_2 without being aggressive. Soft waters are rendered aggressive by relatively small quantities of CO_2."

It is possible that the names of chemical compounds other than "calcium carbonate" could be substituted in these expressions. Calcium carbonate, however, is so universally present in normal waters that, apparently, little advantage is to be gained by such substitution.

This may explain why, in recent years, hydrated or slaked lime have become the most commonly used chemicals in the control of corrosion, at least insofar as public water supplies are concerned. Its low first cost and ease of application explain in part its popularity; but behind these reasons there seems to be an increasing realization that satisfactory control, in many cases, is dependent upon a calcium carbonate equilibrium in the treated water. The advocates of this form of treatment have received confirmation of their opinion in the report of the New England association's committee. The value of marble or limestone beds has not yet been fully demonstrated, but the principles on which the process is based are essentially the same as those involved in the direct application of lime. This method has the merit of extreme simplicity, requiring no skill or care in operation and no possibility of overdosing. It appears to possess especial value for small water works handling waters containing relatively large quantities of CO_2.

In the many technical papers which have been published on this subject of corrosion, little seemingly has been written on a phase of the problem that, for lack of a better expression, the writer has called "Tuberculation in Reverse." When, after a number of years of building up of tuberculated matter on the inside of mains and service lines, comparatively large quantities of lime are applied to the water in circulation in the pipes, it is recognized that new chemical combinations are set up. Under normal conditions the pH, alkalinity, and hardness are rather sharply increased.

What Happens with Lime Treatment

After lime has been added to the water in correct amounts for an indefinite period of time, a deposit is supposed to form on the pipe, which is commonly called an "eggshell" coating (10), after which red water no longer occurs. But, in the intermediate period between the beginning of treatment and the formation of this coating, what takes place? Does this coating form over the original tuberculations, or do the new chemical reactions cause a temporary loosening and sloughing off of old tuberculated material—*i. e.*, do we experience "Tuberculation in Reverse." Apparently such a phenomenon does occur. Other observers have stated verbally that some unusual disturbance has occurred immediately after treatment was begun, and some rather casual mention has been made of such disturbances in published papers (8), but if anything concrete or definite on the subject has been written, it has escaped the author's attention.

To set forth some recent observations, before any further comment is made, it is believed a simple recital of the experiences of the Home Water Company, of Royersford, Pennsylvania, may be of moment. This company takes water from the Schuylkill River, a stream contaminated by sewage and a variety of industrial wastes, including culm and acid mine water from the anthracite fields of central Pennsylvania. The water is low in alkalinity, but high in non-carbonate hardness. A typical raw water analysis is here listed.

	p. p. m.
Color	20
Turbidity	40
Total dissolved solids	354
Volatile matter	28

Fixed residue	326
Ammonia nitrogen	.406
Albuminoid nitrogen	.110
Nitrite nitrogen	.2
Nitrate nitrogen	1.0
Chlorides	3
Oxygen consumed	2.6
Iron	0.4
Hardness	210
Alkalinity	23
pH	6.5

This water, at the present time, is coagulated with alum, pre-chlorinated, and treated with activated carbon; is filtered, again chlorinated, dosed with hydrated lime, and is then pumped through a force main to a distributing reservoir, through which it passes before entering the distribution system. Lime is also used at times for pre-treatment when the alkalinity of the raw water is deficient.

The works are of standard design with no unusual features. Prior to the time corrective treatment was begun, tuberculation of the mains seemed to be steadily increasing. The company, acting on somewhat casual if correct advice, some four years ago began the application of hydrated lime for the correction of the pH, introducing the chemical into the raw water at the inlet end of the coagulation basin. After several months of operation in this manner, deposits of lime were noted on the sand in the filter beds, and the point of application was moved to the filtered water, at the inlet end of the clear water basin. For reasons to be given, the point of application was returned to its original location—the raw water.

Lime Treatment Brought Complaints

The results of this treatment were very discouraging to the company. Prior to the application of lime complaints of red water were not uncommon but, later, (particularly some three or four months after the chemical was applied to the filtered water) these complaints became more and more numerous from consumers over the entire distribution area. It was found impossible to keep the water at the taps in a satisfactory condition, despite almost constant flushing. It was at this time that the point of lime application was returned to the raw water. Finally the treatment was abandoned entirely, but relief did not ensue. It was then that the writer and his associates were called into consultation.

Several lines of attack were made simultaneously. A modern dry feed machine was installed and the lime applied to the filtered water. The distribution system was thoroughly and scientifically flushed, beginning at the reservoir and fanning out to the extreme ends of the system. Careful attention was given to coagulation, improved mixing and conditioning, pH and alkalinity of the coagulated water. Calcium carbonate equilibrium tests were run, using McLaughlin's method (7) for determination. Records were made of the pH and alkalinity of the tap water at certain selected points on the distribution system, and more complete records were kept on plant operation.

The pH of the filtered water was raised slowly, and gradually, for a period of about four months during the winter. It was eventually set and held consistently at pH 8.6, which is slightly higher than the 8.3 to 8.5 indicated as necessary by the carbonate equilibrium tests. This has resulted in the precipitation of some carbonate at the inlet end of the distribution reservoir, but not over the entire basin. This arrangement of the system, whereby water is first passed through the reservoir, has been of advantage. It permits the precipitation of carbonate in the reservoir rather than in the system. Incrustation of meters is thus avoided.

One of the difficulties experienced here, and at other places, as indicated by current literature (9), has been a progressive lowering of the pH of the corrected water in the distributing system, in more or less direct ratio to the distance from the point of treatment to the sampling taps. After a year's application of lime, the maximum pH secured at the ends of the system is about 7.7. The cause for this lowering is not clear. First Enslow, and more recently Hutton (4) have advanced the theory that organic matter, a certain amount of which is always present in the pipe lines, is decomposed slowly, with the production of CO_2 and possibly other organic acids, thus reducing the pH. It is their idea that such decomposition can be prevented or reduced by carrying chlorine residuals into all parts of the distribution system, a procedure which can be accomplished most readily through chloramine treatment. The water company is now installing an ammonia apparatus for this purpose. Whether or not the theory is sound, the additional safety of the water warrants the expenditure for the ammonia apparatus.

It was, and still is, the opinion of the operators of the company, that a softening and dissolving of the tuberculations of the pipes followed the application of lime. As a preliminary experiment, admittedly somewhat crude, a service line which was so seriously tuberculated that it had to be removed by the property owner, was set up in the pipe gallery in the plant, and water with a normal carbonate alkalinity (pH 8.4 and higher) was passed through the pipe continuously for about six months. The line began to discharge red water immediately and continued to do so for several months. At the time it was last examined, most of the coating on the inside of the pipe had disappeared and its carrying capacity was not far from normal for clean pipes.

Further evidence of this reaction was found in the pumping station. A long 1-inch galvanized line is taken off the force main containing the treated water and is carried along the wall of the pumping station to feed the pre-chlorinator, and the tap at the laboratory sink. This line was examined some months before the corrective measures were again begun, and found to be very seriously tuberculated. After treatment was resumed, the water discharged from the line was highly colored and cleared only after a thorough flushing. The inlet screen on the chlorinator had to be taken out frequently and deposits of iron particles removed.

This pipe was again recently dismantled and examined and found, similarly, to be practically free of an internal coating. There was no indication of the formation of an "eggshell" coating.

Still further evidence of the sloughing off is indicated by the number of house meter screens which now have to be cleaned as compared with former years; and by apparently increased pressures at fire hydrants although, unfortunately, no definite figures on pressures are available to prove this observation.

Despite these evidences of sloughing, the effects of the consistent and controlled treatment with lime have been on the whole satisfactory. Complaints from consumers have practically ceased. Such as are received are from small localized areas where changes in the pipe system will be necessary to secure complete relief.

Need for Further Study

The experiences of the water company at Royersford confirm former findings on the effectiveness of corrosion control when proper relationships are maintained between the alkalinity, pH, and calcium carbonate hardness of filtered water. Some criticism has been heard lately as to the value of the so-called "marble" test, for determining calcium carbonate equilibrium in corrosion control.

It appears possible that such criticism may have been based on reactions similar to those which have occurred at Royersford, leading the observer to believe, because conditions did not improve immediately or become aggravated, that the determination had no value; whereas, if the treatment had been carried on for a sufficient period of time, successful results would have been obtained. Tuberculation of pipes is a slow process and remedial measures, seemingly, cannot be unduly hastened.

The need for further research on corrosion control, particularly the involved phenomena of the uncoating of pipes, seems to be apparent. Studies should be made on the chemical reactions involved, accompanied by field observations on pipe lines in use—both steel and iron. This latter phase is the more difficult, because of the inaccessibility of pipes buried in the ground, and of the lack of exposed lines for frequent examination.

Because of advancing sanitation, and of the demands of the consumer for a more perfect product, treatment for the correction of corrosion is certain to become more and more common. The economics of the problem, involving the life of pipe and its sustained effective carrying capacity, will strengthen this demand. In new installations much of the problem can be overcome through the use of service lines of resistant metals; of metal mains with protective linings, or the use of pipes of non-corrosive materials. The many thousands of miles of cast iron mains and service lines of corrodable metals, now in service, will still remain a problem for the engineer and chemist. On this score, the production of less aggressive waters will remain a paramount consideration in the solution of corrosion and tuberculation problems.

Even the coating of mains in place, which bids fair to become an important development in the water works field, will not completely solve the problem. Such a procedure may relieve troubles on supply and distribution mains, but there will still be the problem of the smaller extension mains and the millions of dollars worth of service lines—privately and publicly owned.

Summarizing

The experiences of the Home Water Company, at Royersford, in the control of corrosion and the elimination of red water can be summarized as follows:

1. Treatment with lime has proved effective in the control of corrosion.
2. A reversal of tuberculation, causing an uncoating of the pipes, occurs following treatment with lime or other alkali—in certain waters at least.
3. Where necessary to add lime or other alkali as a corrosion corrective, such should be applied to the filtered, rather than the raw water.
4. The application of lime should be uniform and continuous, and the chemical reactions must be closely controlled. The water must be maintained in chemical balance, as indicated by tests involving rusting of metals and its power to dissolve or deposit calcium carbonate.
5. Thorough flushing of lines is an important part of the control of corrosion in old mains during the early periods after introduction of corrective treatment.
6. Before treatment is begun, an effort should be made to examine the condition of accessible piping, for recording and comparisons in later observations to reveal accomplishments.
7. Adequate records should be kept of the characteristics of the water leaving the purification plant; and, more important, its quality throughout the distribution system. Only with such data is one able to evaluate the results secured, or reach decisions in planning progressive improvements.

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Mohamet Goes to the Mountain

Whether it was as he claims "the Gypsy in me," good business judgment or spring-wanderlust (likely some of all three), we do not know, but Jeff Corydon, President of Proportioneers, Inc., is out on the road with his new "Treatment Trailer." With Mrs. Corydon and an "easy-bite" pipe, he is scouting, larking and demonstrating Proportioneer chemical feeders. He says the mountain couldn't come to Mohamet, so Mohamet is going to the "Mountains," and sooner or later every operator and

The Proud Possession of J. Corydon—the Treatment Trailer, We Mean.

sanitary engineer will have a first hand opportunity to see and feel the "heart pumps" of Proportioneer chemical feed equipment, right at his own front door. Aside from feeling well repaid for investing in the "Treatment Trailer," Jeff Corydon writes that both he and Mrs. Corydon are having the best vacation they could ask for, and sleeping "at home" every night. The only objection is that it's tough to have to pay double tariff to parking lots, but still tougher to back-up.

ELEVENTH CONFERENCE OF MARYLAND-DELAWARE ASS'N

Association Honored by Presence of Delaware's Governor

By HARRY A. FABER*
Associate Editor

WILMINGTON, Delaware, is one city in which depression days were little noted nor long remembered. It was altogether fitting and proper, then, that the Maryland-Delaware Water and Sewerage Association should hold its boom meeting in that city.

At the 11th Annual Conference, May 6th and 7th the registration of 127 bettered all previous records. A fine selection of technical papers, the banquet at which the Governor of Delaware spoke, the floor show, and careful planning by the program committee, all contributed to round out a splendid convention and well attended technical sessions.

In the business meeting it was announced that the association has 175 members distributed as follows: Maryland 114, District of Columbia 16, Delaware 12, and associate members 33. A three-day short school sponsored by the association in September, 1936, had a registration of 32 and granted 28 certificates upon completion of the work. New officers elected for 1937 are:

Edward S. Hopkins, Baltimore, President; C. J. Bruce, Cumberland, 1st Vice-Pres.; A. M. Tawney, Fort Meade, 2nd Vice-Pres.; A. W. Blohm, Baltimore, Secretary-Treasurer; to the Executive Committee—W. N. Spring, Salisbury; J. M. Jester, Hyattsville.

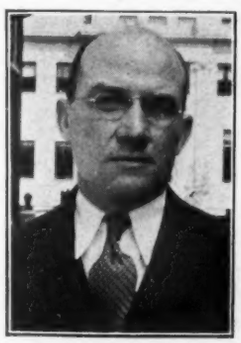
Technical Sessions

(President, J. V. Cannen, Presiding)

"The City of Dover Combined Sewage Treatment Plant and Incinerator"—By FRANCIS S. FRIEL, Consulting Engineer, Philadelphia, Pa.

Dover's new primary-treatment plant, completed July 24, 1936, provides digestion of sludge in heated digesters, sludge drying on glass covered beds, sewage disinfection with chlorine. Odor control is to be secured with chlorinated copperas. The plant is located within 300 feet of dwellings and within 1,000 feet of the new legislative building of the state capitol group. Consequently, particular attention was devoted to minimizing odor nuisance.

* Research Chemist, The Chlorine Institute, New York City.



President-Retiring James V. Cannen, Hagerstown, Md.

President-Elect Edw. S. Hopkins Baltimore, Md.

Left—A. M. Tawney, Fort Meade, Md. (Vice-Pres. and Successful Gadgeteer). Right—A. W. Blohm, Baltimore, Md. (Sec'y of the Association). Center—Miss E. V. Gipe, Baltimore, Md. (Her eleventh year as Recording Sec'y.)

Covered trucks, of a modern type, collect city garbage which is burned with sewage screenings in a Morse-Boulger type incinerator. No auxiliary fuel has been required since the first few days. Specifications are that the incinerator operate without fuel when the refuse contains 35% or more combustibles with not more than 50% moisture. In Dover a contributing population of 5,000 produces an average of 2.79 pounds of garbage per capita per day. This is burned at a rate of 1.33 tons per hour; and, since the design capacity of the incinerator is but 20 tons per 24 hours, the 60% overload operation has been considered a severe and successful test. The average temperature maintained is 1390 F. Ash produced has been 6.5% of the garbage and rubbish burned.

The sludge digester is 30 ft. in diameter and has a side depth of 22 ft. A practice, not recommended by Mr. Friel, but, one found to be possible was that of increasing gas storage capacity beneath the Downe's floating cover by adding ballast in some form. Such was accomplished by placing sand filled bags on the cover to the extent of 2,000 lbs. of ballasting. An average of 0.79 cu. ft. of gas per capita per day is produced. When no gas is stored pressure at the digester is 4.5 inches; when gas is stored, pressure (with ballast) reaches 7.75 inches. Gas heats the plant building and maintains a temperature of not less than 84 F. in the digestion tank.

Unusual facilities, which Mr. Friel described, are the novel scum troughs and the chlorinated-copperas installation. The scum troughs are made from steel pipe 12 inches in diameter, with a longitudinal slot 6 inches wide cut to form a weir. These pipes which are placed horizontally at the effluent end of the tank, rotate in sleeves set in the concrete walls, and are turned by means of 2 inch pipe levers attached to the troughs. Scum, grease, and floating material, brought to the end of the tank by mechanical sweeps, is drawn off periodically by turning the effluent troughs. Material thus collected is burned with screenings in the incinerator.

Three distinct purposes are served by the chlorinator and chlorinated-copperas equipment. Chlorine is used

Geo. L. Hall, Acting Chief Engr., Maryland's Dept. of Health (No. 1 Member of Gadget Award Committee)

R. C. Beckett, Chief Engr., Delaware's Dept. of Health (Honored by having his Governor attend)

alone for pre-chlorination, chlorinated copperas is used to neutralize hydrogen sulfide and prevent odors. In addition, sufficient iron coagulant may be fed in this form to provide chemical precipitation, when such is necessary.

The plant is designed for an average dry weather flow of 1.458 m.g.d. Costs are as follows: plant and outfall sewer, $110,231; treatment plant, $78,000; incinerator, $29,000. Labor was supplied by P.W.A.

"Water Supply and Sewerage in Delaware"—By R. C. BECKETT, State Sanitary Engineer, Dover, Delaware.

According to the data presented by Mr. Beckett, municipal or private water supplies are available to 67% of the population of Delaware, and sewerage facilities are provided for 60%. The state has three filtration plants; 24 towns are supplied by wells, and there is one iron removal plant in operation. Plants are installed to treat only 11% of the sewage. Only 5% of its sewage is given treatment by the city of Wilmington, which appears to be the "problem child" of the state. Until upstream communities and industries, give at least some degree of treatment to their wastes, it looked to be difficult to press a treatment program on Wilmington. In the meantime surveys have been made for suburban sanitary districts contiguous to the city, and while the problem is one of considerable magnitude, progress is being made.

"Water Supply for the United States Army"—By JAMES W. ENGLE, Water Engineer, War Department, Washington, D. C.

Mr. Engle explained that water supply in permanent camps came under the Quartermasters Department of the Army; that of troops on maneuvers under the Engineers' Department. The Medical Department of the Army cooperates with both in making sanitary surveys, laboratory analyses, inspections. Mr. Engle touched on the multitude of conditions which must be considered in the maintenance of water quality so vital to the health and well-being of troops. In as much as many different types of supply and many climatic conditions are encountered problems varied to extremes.

In camp, per capita requirements may vary from 30 or 40 gallons per day to as high as 400 to 500 gallons per day. In contrast with these amounts only 1.5 to 2 quarts per person per day must be provided for troops in combat, and 3 to 5 gallons for animals in the field.

The army has 243 permanent stations and many types of supply must be utilized. Chlorination is universally used, both pressure and rapid sand filters being employed. Aeration and corrosion correction had received only limited attention, whereas, softening by lime-soda or zeolites must often be resorted to. Electric motor driven pumps are employed wherever possible and are generally supplemented with standby gasoline engines. Practically all reservoirs or stand-pipes are covered. Many of the unusual conditions at various camps were discussed in some detail.

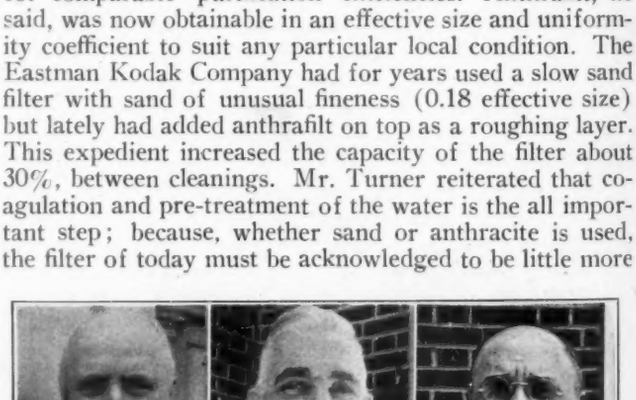
In conclusion Mr. Engle described the mobile water purification units utilizing pumps and pressure filters, equipped with alum and soda ash feeders, and chlorinators. Canvas water storage basins of 4,000 gallons capacity are employed in some cases. Where mobile units are not available, the Lyster bag is used to store chlorinated water as a supply for canteen filling. The impressive decrease in typhoid fever amongst troops, due to improved water quality control, had eliminated one of the most insidious enemies of fighting forces—cholera, typhoid, dysentery.

"Comparison of Sand and Coal Filters"—By J. C. BRUCE, Supt. Evitts Creek Water Co., Cumberland, Md.

Until 1901 the installation of rapid sand filters was restricted by the Hyatt patent and royalties on this type of filter. Beginning in 1906 rapid sand filter installations came into general usage and, of late, crushed coal ("Anthrafilt") has been used as the filtering medium in a number of plants with definite advantages becoming apparent.

Where comparisons of sand and "anthrafilt" have been made, longer filter runs and reductions in wash water requirements have generally been reported. Bethlehem, Pa.; Little Falls, N. J., and the Crumb Creek plant near Philadelphia were mentioned as plants where coal filters are in use and from which such results have been reported. It was indicated that the depth of anthrafilt beds must be greater than sand beds or bacteriological results will be less satisfactory. Because coal is slow to unite chemically, deposits of iron and manganese on the grains are less troublesome, and mud ball difficulties decrease. At the speaker's plant (Cumberland) these advantages had been obtained with coal filters antedating the now available "anthrafilt," and coal filters seem destined to more widespread adoption and usefulness.

HOMER G. TURNER, of the Anthracite Institute, invited to discuss Mr. Bruce's paper, disagreed as to the necessity of having anthrafilt beds greater in depth than sand beds for comparable purification efficiencies. Anthrafilt, he said, was now obtainable in an effective size and uniformity coefficient to suit any particular local condition. The Eastman Kodak Company had for years used a slow sand filter with sand of unusual fineness (0.18 effective size) but lately had added anthrafilt on top as a roughing layer. This expedient increased the capacity of the filter about 30%, between cleanings. Mr. Turner reiterated that coagulation and pre-treatment of the water is the all important step; because, whether sand or anthracite is used, the filter of today must be acknowledged to be little more

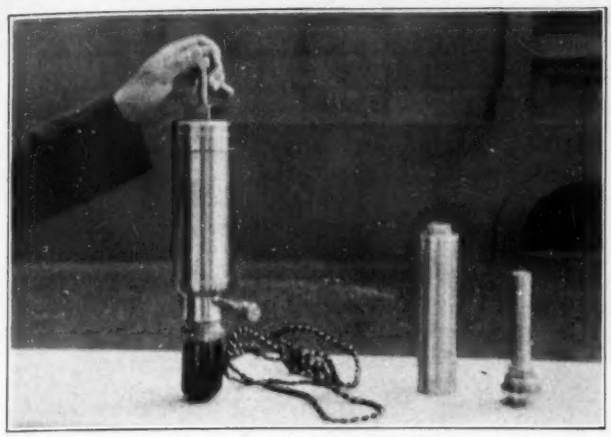


Chas. J. Bruce, Supt. of Water, Cumberland, Md. (1st Vice-President). Harry L. Hall, Chief, Wash. Sub. Sanitary Distr. L. D. Shank, City Mgr., Dover, Dela. (Past Presidents—Both).

than a straining device. And, is counted upon to do less in the way of bacterial removal than ever before.

"Experiences in the Ohio River Flood Areas"—A. W. BLOHM, W. N. SPRING, and L. C. MACMURRAY, Maryland State Department of Health.

At his point, as collaborating engineers with the U. S. Public Health Service, the three speakers presented experiences at their stations during and following the Ohio River flood at Huntington, Wheeling and Parkersburg, West Va. (*Ed. Note*:—Fearing that our readers will have read and heard so much concerning flood experi-



Winning Gadgets—by A. M. Tawney, Fort Meade, Md.

Left—Automatic Electric Heating Jacket for Chlorinator-Tray Water. Right—Chlorine Filter Inserted in Gas Line to Chlorinator. Both Made Up in the Fort Meade Shop.

ences by the time this issue reaches them, Mr. Faber's report has been cut at this point to a mere note of record. We take this opportunity, however, to acknowledge the long hours of service rendered by the three speakers, and hope for their forgiveness in the deletion.)

"The Effect of Distillery Wastes on Sewage Treatment Plants"—By J. CARBERY BOYLE, Chief Plumbing Inspector, Westminster, Md.

In the absence of the speaker, Secretary Blohm, familiar with the Westminster situation, presented the data in brief. In 1935 Westminster obtained a sewer system and complete treatment plant as a P.W.A. project. Plant, pumping station, and sewerage system cost $285,000 and was built to serve a population of 5,000. Design was on the basis of 0.75 m.g.d. or 150 gal. per capita per day.

The treatment provided is clarification, trickling filters (rotary distributors) and secondary clarifiers. A covered sludge digester is in use, but gas produced is discharged to the atmosphere. Until the spring of 1936 plant operation was satisfactory, but at that time distillery waste was added to the sewage. Foaming conditions in the primary and secondary clarifier followed, and solids were carried over to the stream. Sludge in the digester was made very acid (below pH 4.0), and although reductions in B.O.D. and total solids amounted to about 91%, the plant effluent was stronger than had previously been the case with raw sewage.

Lime was applied to raise the pH of the sludge in the digester but foaming continued. It was decided to try chlorination of the digester, and roughly 18 pounds of available chlorine was then added in the form of HTH. The latter treatment returned the digester to a satisfactory operating condition. Provision has now been made to dispose of distillery slop to farmers who haul it from the liquor plant. In emergency the distillery is allowed to dilute the waste with water (1 to 100) and add it gradually to the sewer. Sewage plant troubles are not yet over, however, as packing house wastes are now received twice weekly. It was worthy of note that, even with these wastes, it had been found that digester foaming could be controlled by the use of chlorine.

Morning Session, May 7th

(President-Elect Edward S. Hopkins, Presiding)

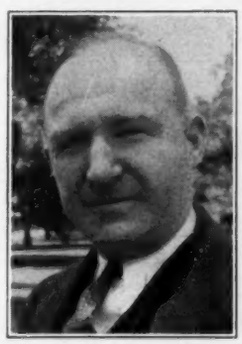
"Modern Trends in Water Bacteriology"—By DR. J. F. DOMINICK, Dalecarlia Filtration Plant, Washington, D. C.

Dr. Dominick reviewed the development of water bacteriology and deprecated the usual methods as giving results too delayed to yield anything but a "historical record." Years of careful research have shown that many investigations have found aerogenes organisms in intestinal discharges. Methods of differentiating culturally between members of the coli-aerogenes group were described, but the tendency of many bacteriological workers to regard aerogenes pollution as of no potential danger seems highly questionable.

By taking samples from ten actual autopsy cases, 200 cultures were obtained from intestines and 6% of these showed aerogenes organisms to be present. Therefore, the aerobacter group was considered by the speaker to be as important an indicator of fecal pollution as the coli group. A definite relation between the slow or non-lactose fermenters and epidemic dysentery seems indicated, and Dr. Dominick criticized present indices of sewage pollution as too lenient. The trend in the proper direction, he said, is toward higher chlorination and, thereby, higher safety.

Confirmatory liquid media showing characteristic color and gas changes were exhibited. Brilliant Green Bile Broth was noted as giving excellent confirmatory results, Fuchsin media was regarded as satisfactory. Data obtained with Bromcresol Purple and McConkey's media were also reported. Advantages of using lactose broth with suitable dyes and buffers were cited.

[Dr. Dominick's discussion was a splendid presentation by a man who knows his subject and how to make it interesting.—Ed.]



Francis S. Friel, Consulting Engineer, Philadelphia.

Harry A. Faber, Research Chemist, The Chlorine Institute.

"Algae and Its Control"—by CARL J. LAUTER, Dalecarlia Filtration Plant, Washington, D. C.

The Dalecarlia plant and additions to it were designed only for bacterial removal, whereas, recent algae troubles have at times made operation extremely difficult. A heavy growth of Synedra in 1936 decreased filter runs from the usual 60 or 70 hours to only 2 hours. Mr. Lauter prefers to use number of organisms per cc. as a more significant term than standard units. Under the conditions mentioned, Synedra increased from 2 or 3 to 4,000 per cc.

Carl J. Lauter, Supt. Filtr., Washington, D. C. (Synedra cost Washington $8,550; Lauter loss of sleep.) J. G. Patrick, W. Va. Pulp and Paper Co., Luke, Md. (Removes Manganese from Filters and Pipe Lines with SO_2.) J. F. Dominick, Bacteriologist, Washington, D. C. (Knows His "Bugs"; Has a Media Bearing His Name.)

Copper sulphate and chlorine were immediately added to the reservoir intake to combat the growth.

The water supply situation is complicated by the fact that 50% of the water from a 200 million gallon reservoir is used by a hydro-electric plant. Treatment of the entire supply at the source therefore becomes an impracticable and expensive procedure. While the copper and chlorine treatment perhaps killed the majority of organisms, Synedra being of low density floated onto the filters. Alum dose was raised on the basis of previous experience and doses of as much as 4 grains per gallon were required to produce longer filter runs.

During the trouble laboratory tests were run on various groups of coagulants and checked by microscopical counts of organisms removed. These tests showed iron, lime, and chlorine (using doses of 2, 1, and 1 grains per gallon, respectively) yielded the best removals of any of the coagulants tried. Examination of the floc showed most organisms to be enmeshed by this type of coagulation, and the results were consistent. Important economically were the cost figures presented:

TOTAL EXCESS CHEMICALS OVER NORMAL TREATMENT FOR THE SAME TURBIDITIES

Chemical	Amount	Total Cost
Alum	367 tons	$7,340
Lime	43 tons	430
Chlorine	2,700 lbs.	81
Copper Sulfate	11,400 lbs.	700
Excess chemical cost		$8,551*
Cost per m. g. treated		$ 4.10
Estimated cost on basis of lime, iron and chlorine treatment as designated above would be		$6,530
Cost per m. g.		$ 3.12
Estimated saving over the actual cost		$2,021
Saving per m. g.		$ 0.98

In addition to cost of chemicals 28 m. g. of excess wash water was required, due to shortened filter runs. This, at $20 per m. g., would add another $560 to the cost of treatment during the Synedra epidemic.

A survey of the Potomac and every contributing stream failed to disclose the cause of the Synedra increase. Only in the lower river, below Shepardstown, was the growth abnormal. No warning had been given by change in pH of the water, while in 1934 when a different algae growth had been troublesome, the pH had increased to pH 8.8. No bad odors were apparent, probably because chloramine treatment is used for disinfection.

In the discussion following L. H. ENSLOW suggested that ordinarily prevention of such a condition was better and far less costly than cure. Because of the tremendous volume of water which must be treated, however, pretreatment could not be applied. He asked how chlorine was added in the iron, lime, chlorine coagulation tests. MR. LAUTER replied that chlorine was added along with or immediately after the iron. Without the chlorine, the iron sulphate alone proved useless. The same amount of chlorine was added in alum coagulation as was used with iron and lime—The iron floc, however, seemed to enmesh greater numbers of organisms than did the alum floc.

E. S. HOPKINS noted that the warning increase in pH of water accompanies the growth of blue-green types of algæ but not other types.

"Removal of Manganese Deposits by the Use of Sulfur Dioxide Gas"—By J. G. PATRICK, West Virginia Pulp and Paper Company, Luke, Md.

The 12 m.g.d. water filtration plant supervised by Mr. Patrick was built to supply a paper mill and does so at a cost of $8.00 per m.g. Operating at an overload, the plant has been troubled with sand coatings and mudball conditions in the filters. Many curative schemes have been suggested, but the use of sulphur dioxide (SO_2) gas has been found most effective by Mr. Patrick for cleaning filter sand, under drains, pipe lines.

Describing plant operation, he said the original installation cost was $250,000; water is supplied for industrial use and for potable purposes to the plant and to the town of Luke; only 0.2 m.g. storage, or 10 minutes supply is provided; the raw water is contaminated with about 50 tons per day of sulfuric acid from coal mine drainage; caustic soda, filter alum, and "Nuchar" are applied to secure coagulation.

First attempts to clean filter sand employed 2% caustic soda. This solution remained in the filters overnight, sand was stirred with an air lance, but only a partial cleaning was effected at a cost of $37 per filter, and loss of service for 40 hours. The water contains 1.0 p.p.m. iron in the raw and 0.17 p.p.m. in the treated effluent. Manganese is not removed, varying only from 0.3 p.p.m. in the raw to 0.26 in the filtered water.

Snapped Between Sessions

(1) W. D. Collins, U. S. Geol. Survey (Washington); (2) J. M. Jester, Morse Filtr. Plant (Burnt Mills). (3) H. E. Beckwith, Pitometer Co. (Harrisburg, Pa.); (4) G. E. Harrington, Member Exec. Comm. (Washington); (5) E. F. Donaldson, Supt. Filtr. (Annapolis, Md.); (6) J. R. Cronister, Supt. Water (Cambridge, Md.); (7) G. M. Boone, Supt. Water, (Mt. Wilson, Md.); (8) Wm. Krumbine, Supt. Water (Easton, Md.)

*Normal cost would be $2,930; normal cost per m. g., $1.40.

Black deposits (coatings) of manganese dioxide in the mill pipes, broke away after a few months of operation, and appeared in the paper manufacturing processes. An alkaline condition of the finished water (pH 10.0) was maintained to prevent corrosion, and this seemed to be responsible for rapid MnO_2 precipitation in the mains.

Since sulfur dioxide gas could be conveniently added from a cylinder and forms sulfurous acid in water solution this method was next tried. Underdrains and filter bed were filled slowly with a 0.2% solution of SO_2 which stood in contact with the sand overnight and then was flushed out. Such a dose did not clean the sand but did eliminate dirt from the filtered water. Up to 3% strength proved that required to effectively clean deposits from sand. Both manganese and iron are changed to soluble forms and pipes are freed of deposits by this method.

Mr. Patrick pointed out such advantages as convenience and economy for this method. Liquid SO_2 costing 10 to 12.5 cents per pound, may be fed from the cylinder by using a standard chlorine adapter, diffuser or injector. Because of the high solubility of the gas only 10 minutes are required to empty a cylinder and little labor is involved. The sulfurous acid reaches all parts of the system, and is not dangerous to handle.

In reply to a question Mr. Patrick said the $8.00 per m.g. cost included depreciation, labor, maintenance, and pumping costs — delivery of water right to the mill. Asked by Mr. Enslow as to the reason for the use of caustic soda instead of lime he explained that it was used instead of lime to avoid hardening of the water used in paper making—also for convenience and ease of control. Soda ash could not be used because it caused foaming.

"Air Conditioning and Its Relationship to Public Water Supplies"—By COL. W. A. DANIELSON, Washington, D. C.

W. N. Spring, Md. Dept. Health Engr., Salisbury, Md. J. W. Engle. Water Engr., U. S. Army, Washington. Col. W. A. Danielson, Washington. (Would Have Water Works Allow Use of Supply for Cooling, Thereafter Returned to Mains, as Solution to Supply Problem in Air Conditioning.)

cussion was, that water supply systems are largely already taxed to their capacity; that air conditioning will require increasingly larger volumes of water. Therefore, why not use water from public mains to cool condensers and then (with not too large an increase in temperature from the heat exchange process) return this water to the mains for domestic supply? In his opinion little health hazard exists because of such a cross-connection to the supply—in fact, he believes health authorities and waterworks officials, are fallaciously cautious in objecting to such a scheme. He admitted cooling systems employing ammonia were objectionable because of the solubility of this gas but described such new refrigerants as "Freeon" as being only slightly soluble in water and non-toxic and non-detectable to consumers. The more serious questions the Colonel ignored.

Vigorous denial of over-caution in regard to cross connections was made in reply to the speaker, by Mr. Enslow and Mr. Dominick. They cited the hidden dangers and potential hazards in Col. Danielson's suggestions.

The water works profession, they believe, will be justly adverse to the proposed suggestion concerning dual use of a water supply—in short; the proposed "renting" of the water, adding to it heat and returning it to the public system.

Helped Swell Attendance to Record Numbers

(1) L. R. Whitcomb, Pardee Engr. Co. (Philadelphia); (2) E. R. Neff, Commissioner Water (Cumberland, Md.); (3) A. J. Feeney, Asst. Chief, Water Dept. (Wilmington); (4) A. B. Millard, Operator, Ft. Meade, Md.; (5) I. S. Keefauver, Supt. Filtr. (Frederick, Md.); (6) Robt. Norris, State Hospital, Sykesville, Md.; (7) M. F. Corin, Permutit Co. (Philadelphia); (8) Bob Clement, W. & T. Co. (Washington).

Discussing newer developments in air conditioning, Col. Danielson, as chairman of Research Committee on Air Conditioning (Am. Soc. Heating and Ventilating Engrs.), mentioned supersonic waves and fever therapy research as the outcome of early experiments in this field. In California laboratory work showed that the condition of the human body determines susceptibility to colds. However, in air conditioned chambers, the same subjects had not contracted colds when exposed to infectious discharges.

The quantity of water required for cooling systems was naturally a consideration of great importance, but probably would decrease with advanced knowledge of cooling. Special sunscreens (an exterior venetian blind) and new lamps which contain an efflorescent material and consume about one-quarter of the usual wattage promise much in reducing interior heat.

What seemed to be the theme of Col. Danielson's dis-

Afternoon Session, May 7th

(A. M. Tawney, 2nd Vice-Pres., Presiding)

"Chemical Precipitation and the Hagerstown Sewage Treatment Plant"—By H. W. RHODES, Supt. Sewage Treatment, Hagerstown, Md.

In the absence of the author of this paper, it was read by Harry A. Faber, Research Chemist of The Chlorine Institute, who had supervised plant scale experiments at Hagerstown in 1935. The activated sludge process of

sewage treatment is ordinarily employed, but the plant is so constructed that chemical treatment may be employed in half of the plant and comparisons of efficiency may be made with the biological process. In 1935 chlorinated copperas with excess chlorine was shown to prevent sludge bulking and to decrease operating costs.

[The results of the plant scale experiments have been published in the June, 1936, issue of WATER WORKS AND SEWERAGE.—Ed.]

The present paper was largely concerned with reporting data from experimental use of the Guggenheim process at Hagerstown through the five summer months of 1936. The entire sewage flow was treated by this process by the Guggenheim organization and unfortunately no comparative biological data was available as in previous tests. Results, as reported, were:

	Max.	Min.	Avg.
Effluent B O D (p. p. m.)	49	19	33
Effluent susp. solids (p. p. m.)	37	21	25
Per cent B O D removal	87	76	83
Per cent susp. solids removal	88	83	87
Air consumption (cu. ft. per gal.)	.26	.41	.34
Iron dose required (p. p. m. Fe*)	13	11	11.8

*"Ferrisul" (Ferric Sulphate) and (later) chlorinated copperas were employed.

Mr. Rhodes concluded that chemical precipitation produces a good quality of effluent at a slightly lower cost than activated sludge treatment; that less plant size would be required by adopting the chemical process. However, it appeared that with it all equal technical control and skill would be as necessary as for the biological process. It was found that the chemical sludge could be more readily and economically dewatered than was true with the mixed crude and activated sludge.

"The Formation of the Interstate Commission on the Delaware River Basin"—By DAVID W. ROBINSON, Acting Secretary, Philadelphia.

Development of National water resources has stimulated the local development of such interstate programs as those of New York, New Jersey, and Pennsylvania as well as the cooperative Delaware River area. Mr. Robinson described the functions of the interstate commissions, as councils of state governments, and the manner in which they functioned with respect to specific water problems. He noted the difficulties which must be overcome in the use of rivers for water supply by cities located in separate states. Large problems confronting such commissions are—standards of cleanliness, allocation of waters to states, and the mapping of present resources.

[To Mr. Robinson's well presented paper this curtailed account is—admittedly unfair—except as a recording.—Ed.]

Gadgeteers and Awards

The meeting closed with the Gadget Contest, in which five members exhibited a total of nine original gadgets and spoke briefly on the respective purpose and advantages of each. A jury consisting of Messrs George Hall, I. M. Glace, and L. H. Enslow awarded prizes as follows:

First Prize of $10.00 went to A. M. Tawney, Supt. Water and Sewage, Fort Meade, Md., for his chlorine gas line filter, which eliminates the necessity of blowing off of cylinders, and his chlorinator tray water heater with automatic control.

Second Prize, one year's subscription to WATER WORKS AND SEWERAGE magazine, went to A. A. Bailey, Supt. of Mechanical Equipment. Montebello Filters, Baltimore, for the ingenious arrangement of a diaphragm spring-valve to prime centrifugal pumps in automatic start-and-stop, or remote control operation. [It is described by Mr. Bailey elsewhere in this issue.—Ed.]

Honorable Mention was voted H. R. Hancock, operator of the Dover, Del. Sewage Plant, who submitted models of ingenious sludge and gas samples, and a scheme for loosening sludge deposits in tanks.

[Note—The 1938 meeting was voted to Washington, D. C.]

(Adjournment)

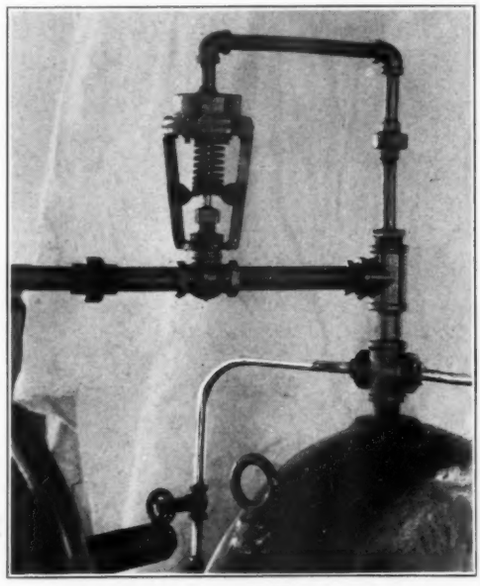
▼

Automatic Pump Priming Valve

By A. A. BAILEY*

Baltimore, Md.

The automatic priming pump valve is for use in the pipe line connecting main pumps with the vacuum priming pumps. In sizes of 1 inch and less, it is a simple globe valve operated by hydraulic pressure on a diaphragm. A hydraulic cylinder with cup leathers is used for sizes above one inch. A spring under the diaphragm keeps the valve slightly open when the main pump is not running. Automatic pump starting or remote control is possible with the use of this valve, as no attention is necessary during its operation. The pressure side of the diaphragm or hydraulic cylinder is connected into the pipe line between the valve and the main pump.



Automatic Pump Priming Valve

When the priming pump is started, the vacuum created opens the priming valve wide, allowing a free flow through the valve. When the pump is completely primed and started, pressure built up in the pump closes the priming pump valve and keeps it closed as long as the pump is running.

With the use of a valve of this type, a great many combinations of starting equipment such as float, pressure, or time control switches can be used successfully.

[This priming valve, an invention of the author, proved a prize winning entry in the 1937 Gadget Contest of the Maryland-Delaware Water and Sewage Works Association.—ED.]

*Superintendent of Mechanical Equipment, Montebello Filters, Baltimore.

COAGULATION

Part 3. Preparation of Silicate Solutions

One of a Series of Articles Dealing with the Use of Silica Solutions to Aid Coagulation

By JOHN R. BAYLIS*
Associate Editor

John R. Baylis

PREVIOUS remarks on difficulties experienced in the preparation of silicate solutions, which will aid coagulation, probably have given the impression that it is not an easy task to prepare the desired kind of solution. The preparation is not difficult with instructions to follow, but considerable work was required to find the conditions under which suitable solutions can be prepared so that instructions probably should be given. This, of course, was caused by lack of knowledge of the form of silicon which aids coagulation. Much of the early work was confined to preparing solutions by carbonating weak solutions of sodium silicate, believing that it would be better to use a weak acid than a strong one.

Not all of the carbonated solutions gave the aid desired to coagulation, so it was decided to try a strong acid. More encouraging results were obtained in that suitable solutions could be prepared without failure of some of them to produce the desired aid to coagulation. Perhaps a procedure for carbonating the solutions may be worked out which will give results equal to that of sulfuric acid.

Silicate Solutions for Laboratory Experiments

Silicate solutions may be prepared by diluting sodium silicate with water and nearly neutralizing the alkali with sulfuric acid. The most beneficial solutions seem to be those containing 1.0 to 1.5 per cent of SiO_2 at the time of preparation. Such solutions may be diluted after they have reached the stage in which they give maximum aid to coagulation, but to dilute them earlier seems to interfere with their development to the stage where they give maximum aid. The solutions do not become active immediately, but an interval of from a few minutes to several hours is required, depending on conditions, for their helpful properties to develop. Solutions containing less than about 0.5 per cent SiO_2 usually cannot be made very active, or at least the procedure which was used did not produce very active solutions.

Solutions which will aid coagulation probably can be prepared from most any of the grades of sodium silicate, but as the silica is the substance which gives the aid, a material high in silica probably is the best. A grade of material known as 42° Baume sodium silicate, which contains 9.0 to 9.5 per cent Na_2O and 29.0 to 30.0 SiO_2, has worked satisfactorily. The procedure which will be given for preparing solutions of acid-treated sodium silicate applies to the solutions which will aid coagulation when aluminum sulfate is used as the coagulant. The iron compounds also are aided by such solutions, but it is not known if the solutions most suited for aluminum sulfate will give maximum aid to the iron coagulants. This will be investigated more fully at a later date.

The SiO_2 Content of the Sodium Silicate.—Determine the SiO_2 content of the sodium silicate. The manufacturer may be able to furnish the percentage, otherwise a chemical test on the material is essential. Add about 0.7 cc. of the sodium silicate to a weighed platinum dish, and determine the weight. Dilute with distilled water to about 25 cc., and add 4 to 5 cc. of hydrochloric acid. Evaporate to dryness on a water bath then place on a hot plate, or in a drying oven, at 110 to 120 deg. C. for 15 to 20 minutes. Add a little water and several drops of hydrochloric acid, allow to stand a few minutes and transfer the solution and precipitate to a filter paper. Wash the precipitate thoroughly. Add several cc. of hydrochloric acid to the filtrate and again evaporate to dryness. Filter in the same manner as before, using a separate filter paper, and wash the precipitate, if any, thoroughly. Combine the two filter papers in a platinum dish and ignite in a muffle furnace. If great accuracy is not essential, one evaporation to dryness is sufficient. To avoid loss of some of the silica particles in burning the filter paper, the furnace door should not be opened until it is evident all the volatile matter has been driven off. Cool, weigh, and add sufficient hydrofluoric acid to volatilize the silica. After the excess hydrofluoric acid is driven off by heating on the hot plate, again ignite in the muffle furnace, cool, and weigh. The loss in weight is the SiO_2. The percentage of SiO_2 in the sodium silicate then may be computed.

Dilute Silicate Solution.—Assume that it is desired to produce a solution containing 1.5 per cent of SiO_2, or 0.015 gram of SiO_2 per cc. of solution. Should the sodium silicate contain 29.0 per cent of SiO_2, 51.72 grams of the material diluted to 1 liter will give a solution containing 0.015 gram of SiO_2 per cc. As the solution has to be nearly neutralized with acid it should be made stronger than 1.5 per cent SiO_2 at first. For convenience in measuring and calculating, prepare the solution to contain 0.030 gram SiO_2 per cc., which is double strength.

Sulfuric Acid Solution.—Prepare a solution of sulfuric acid of some known normality. For small amounts of acid-treated sodium silicate, such as would be prepared for conducting laboratory experiments, a solution of acid exactly normal is preferred, though stronger solutions may be used.

Preparation of Acid-Treated Sodium Silicate Solution.—Dilute 50 cc. of the silicate solution containing

*Physical Chemist, Division of Water Purification, Department of Public Works, Chicago, Ill.
[1]Parts 1 and 2 are to be found in the December, 1936, and February, 1937, issues of this magazine.

0.030 gram per cc. to about 85 cc. with distilled water. Add two drops of phenolphthalein solution, then add the N/1 sulfuric acid with the aid of a burette until the pink color of the solution disappears. Add the acid rapidly at first, then drop by drop until the time required for the pink color to reappear is 10 to 15 seconds. The solution should be agitated during the addition of the acid. Note the amount of N/1 acid used. Dilute the solution to 100 cc. A 10-cc. portion of this acid-treated sodium silicate is diluted to 50 cc. with distilled water. Add two or three drops of methyl orange solution and titrate with N/50 sulfuric acid until the color begins to turn pink. Titrate to the same shade of color used in making alkalinity tests on water. Record the total number of cc. of N/50 acid required.

If the solution is properly acidified, 11 to 13 cc. of the N/50 acid is required to make the 10-cc. portion of the silicate solution slightly pink to methyl orange. Assume that 15.0 cc. of the N/50 acid are required, and that it is desired to adjust so that only 12-cc are required. This is a difference of 3.0 cc. of the acid for the 10-cc. portion, or 30 cc. for 100 cc. Thirty cc. of N/50 acid is equivalent to 0.6 cc. of N/1 acid, so 0.6 cc. more of the N/1 acid than was used should bring the solution to the desired alkalinity. This should be tried on another portion of the sodium silicate, omitting the addition of the phenolphthalein. If the solution is still slightly more alkaline than desired, a third trial should result in the addition of the proper amount of N/1 acid. If the solution is too acid a small amount of sodium silicate should be added or another solution prepared. Usually the second solution is so close there is no need to prepare another one. For one of the 42° Baume sodium silicates used in some of the experiments, 12.6 cc. of N/1 sulfuric acid were required to produce a solution in which 12 cc. of N/50 acid made the 10-cc. portion slightly acid to methyl orange.

Thought has been given to a term with which to designate the acid-treated solutions. Perhaps they should be known by their alkalinity, expressed in the manner used in designating the alkalinity of water. A solution in which 12 cc. of the N/50 acid is required to make a 10-cc. portion slightly pink to methyl orange should be designated a 1200 alkalinity solution, and one requiring 12.8 cc. a 1280 alkalinity solution. The main reason for using alkalinity is that most water treatment plant operators are familiar with the alkalinity test.

Efforts have been made to use pH as a measure of the equilibrium of the solution, but the pH value changes. It may be 8.0 to 8.5 a few minutes after the acid is added, and change to a pH of 9:5 to 10.0 several hours afterwards. A relation between the pH and alkalinity may be found which will give better interpretation of the activity of the solution, though this relation has not been studied as yet. One reason why it was difficult to prepare suitable carbonated solutions was that no exact measure of the equilibrium could be made. The alkalinity test is not suitable for a carbonated solution.

The statement in a previous paragraph that the alkalinity of the solution should be between 1100 and 1300 is not to convey the impression that solutions within this limit are the same. A solution having an alkalinity of 1100 may form a jelly within several hours, whereas a solution having an alkalinity of 1300 probably will stand several weeks before it changes to a jelly. Some of the characteristics of the solutions with various alkalinities are given in another paragraph.

When the solution is to be kept for several days, the alkalinity should be between 1250 and 1350. Unfortunately such a solution requires several hours to develop to the condition which gives maximum aid to coagulation. If the solution is to be used the same day it is prepared, the alkalinity should be between 1100 and 1200. This lower alkalinity solution will give excellent aid to coagulation within one to two hours after its preparation.

Instructions Apply to a Certain Grade of Sodium Silicate.—These instructions apply only to the grade sodium silicate which was used; that is, 41 to 42 Baume material having a Na_2O-SiO_2 ratio of about 1.0 to 3.2. This is a grade of sodium silicate used extensively for a number of purposes. The equilibrium found most desirable for this type of sodium silicate also may be near the equilibrium for other grades of material. However, tests have not been made on other materials.

Preparation of Acid-Treated Sodium Silicate Solutions for Plant Use

A large volume of acid-treated sodium silicate solution may be prepared in the same general manner as the laboratory solutions. To lessen the danger of the solution becoming a jelly, it should be diluted with water after the solution has reached the active state, which may be from one to several hours. The change in the activity of a solution on standing is explained in another paragraph. The percentage of SiO_2 in the diluted solution should be between about 0.2 and 0.6, though tests have not been made on solutions weaker than 0.3 per cent SiO_2. There may be no limit to the dilution which may be made after the solution has become active.

Determine Strength of Sulfuric Acid.—The percentage of H_2SO_4 in the concentrated sulfuric acid should be determined on the basis of weight; that is, one pound of 93.19 per cent acid (66° Baume) contains 0.9319 pounds H_2SO_4. The specific gravity of 93.19 per cent acid is 1.8354, and one liter of the acid contains 1710 grams of H_2SO_4. N/1 Sulfuric acid contains 49.04 grams of H_2SO_4 per liter, so 28.7 cc. $\left(\frac{1000 \times 49.08}{1710} = 28.7\right)$ of the acid per liter will produce a normal solution. Usually there is some knowledge of the approximate strength of the acid. If the acid is 93.19 per cent H_2SO_4, dilute 28.7 cc. to one liter with distilled water, and test with normal sodium carbonate, using methyl orange for the indicator. Should the acid not be exactly equivalent to the sodium carbonate, the amount of acid which should have been used to make it equal may be computed. From this, the per cent H_2SO_4 in the acid is determined. As it is important to know the exact per cent of H_2SO_4 in the concentrated acid, another trial should be made if the first acid soltuion varies from N/1 by more than about 2 per cent.

Preparation of 0.5 Per Sent SiO_2 Solution.—Assume that it is desired to prepare 1000 gallons of a 0.5 per cent SiO_2 solution. A solution containing 0.5 pound of SiO_2 per 100 pounds of water will contain 41.7 pounds of SiO_2 in 1000 gallons of the solution. If the sodium silicate is 29.9 per cent SiO_2, then 139.5 pounds of the sodium silicate are required. The amount of acid for a given weight of SiO_2 in the sodium silicate is determined, then the acid required for the 41.7 pounds of SiO_2 is computed.

A certain shipment of 42° sodium silicate, containing 29.9 per cent of SiO_2 and 9.4 per cent of Na_2O, required a weight of H_2SO_4 which was 0.412 times the weight of SiO_2 to adjust the solution to the desired equilibrium.

TABLE 8—SODIUM SILICATE DILUTED WITH WATER AND TREATED WITH SULFURIC ACID

The sodium silicate contained 9.4 per cent of Na_2O and 29.9 per cent of SiO_2. Solutions containing 5 per cent of the sodium silicate were prepared and treated with a 10 per cent solution of sulfuric acid.

Solution Number	CC of 1 to 9 H_2SO_4 Added to 100 cc. of Sodium Silicate Solution	pH 15 to 30 Min.	pH 24 Hours	Cubic Centimeter of N/50 Sulfuric Acid per 10 cc of Sodium Silicate Solution Required to Neutralize —Phenolphthalein— 1 Hour	—Phenolphthalein— 24 Hours	—Methyl Orange— 1 Hour	—Methyl Orange— 24 Hours
20	3.3	9.5	9.7	6.5	7.9	13.5	13.5
21	3.0	10.0	10.2	9.3	11.8	17.1	17.1
22	3.2	9.6	9.8	7.2	8.9	14.8	15.0
23	3.4	9.0	9.6	4.0	5.4	10.6	10.5
24	3.6	7.8	8.8	.6	1.5	6.4	6.5
25	3.8	7.0	(Formed jelly within 13 minutes)				
26	3.7	7.2	8.4	.0	.4	5.0	4.9
27	4.0	4.0	4.0	..	(Slightly acid)		..
28-a	4.0	4.0	4.0	..	(Slightly acid)		..
28-b	..	..	10.0	..	7.5	..	13.0
29	3.4	..	9.4	..	..	11.0	11.0
30	3.8	..	8.8	..	1.8	6.0	6.0

The pH above 9.5 and below 5.0 may not be exact. Solutions 24, 26, 27, 29, and 30 were diluted after the acid was added. Some of the alkalinity and pH tests were made after dilution. A portion of the solution which would give 10 cc. of the original solution was used for making the alkalinity tests.

As the acid is used to neutralize most of the alkali in the sodium silicate a relation between the acid and the sodium of the silicate seems more logical, but as determination of the acid to be used has to be made on each shipment of sodium silicate, no advantage is gained in making it on the basis of the sodium.

Sodium silicate solutions that are diluted to where the SiO_2 content is below about 1.0 per cent do not develop to a very active state, so when it is desired to prepare a solution containing less SiO_2 than 1.0 per cent, the solution should first be made stronger and diluted after development to the active state. Success has been found by preparing a solution with approximately 1.5 per cent SiO_2 acidified to an alkalinity of 1100. Such solutions developed to the extent that they gave excellent aid to coagulation within about one hour, and were then diluted to solutions containing 0.6 per cent SiO_2. The fact that a 1.5 per cent solution of SiO_2 at an alkalinity of 1100 may form a jelly within three to four hours, it is important to make the dilution within 1.0 to 1.5 hours after preparation. Where it is more convenient to delay diluting the stronger solutions to several hours, the alkalinity of the stronger solutions should be at least 1200.

Effect of Varying the Acid Used

Table 8 gives data on the characteristics of several solutions in which the acid was varied so that they would vary from solutions which were strongly alkaline to solutions slightly acid. The table shows that small variations in the amount of acid greatly influence the characteristics of the solution. The range in which good solutions may be prepared is only about 0.3 per cent of the acid. This may be so narrow that difficulty will be experienced in practice in preparing solutions to use as an aid to the coagulation of water. Table 9 gives comparison of the effect of some of the solutions on Lake Michigan water. Of the solutions tried, the table shows that solutions 20, 23 and 30 gave the best results when used one to several days after preparation. For immediate use, a less alkaline solution would have been better. The solutions cannot be made acid, for acid solutions retard coagulation. The paragraph following gives notes on the characteristics of the solutions which could not be easily placed in tabular form.

Characteristics of Solutions.—Solutions 20 to 24, and 25 to 30 were kept for several weeks and coagulation tests to compare the various solutions were run at intervals on the lake water. The characteristics of the solutions are as follows:

20. The solutions formed a jelly in 33 days. It gave excellent aid to coagulation 24 hours after being prepared, but did not give much aid shortly after being prepared.

21. The solution did not form a jelly within 27 days. It gave almost no aid to coagulation shortly after being prepared, but the aid increased on standing. The solution was not as good as No. 20. After standing 27 days it was made more acid (alkalinity 1280) with some improvement in its aid to coagulation.

22. The solution did not form a jelly within 5 weeks. It gave better aid to coagulation shortly after being prepared than No. 21, though it was not as good as No. 20.

23. The solution formed a jelly in 20 days. It gave

TABLE 9.—COMPARISON OF VARIOUS ACID-TREATED SODIUM SILICATE SOLUTIONS ON THEIR EFFECT UPON COAGULATION OF THE LAKE MICHIGAN WATER.

10 p.p.m. Aluminum Sulfate; 6° C.

Silicate Solution Number	P.P.M. SiO_2	pH	Minutes Stirring Required to Form Coagulation—Just Visible	Small Particles	Fairly Good	Good	Excellent	Immense	Turbidity After Filtering
	.0	7.2	5	7.5	10	15	30	....	0.0
20	4.5	7.2	3	3.5	4	4.5	5	10	0.0
21	4.5	7.2	4	4.5	5	7.2	10	....	0.0
22	4.5	7.2	3.5	4	4.5	5	7.5	12.5	0.0
23	4.5	7.2	3	3.5	4	4.5	5	10	0.0
26	4.5	7.2	3.5	4	4.5	5	7.5	12.5	0.0
27	4.5	7.2	15	30	(No change after 30 minutes)				10.0
28-a	4.5	7.2	25	40	(No change after 40 minutes)				10.0
28-b	4.5	7.3	4	5	7	8	9	12.5	0.0
29	4.5	7.3	5	7.5	8	9	10	....	0.0
30	4.5	7.3	3.5	4.2	5	6	7	10	0.0

Note.—The turbidity of the raw water when no silicate was used, and when solutions 20, 21, 22, 23, 26, 27, and 28-a were used, was 30. When solutions 28-b, 29, and 30 were used, the turbidity was only 4. Where no time is given under the heading "Immense," such a coagulation was not produced by the treatment.

excellent aid to coagulation, and was as good within 24 hours as was solution 20 within 3 days.

24. The solution started to form a jelly within 40 minutes, but was diluted with water to 3 times its volume. It was agitated violently after dilution, and the diluted solution required 22 days to form a jelly. Some aid was given to coagulation, though it was not as good as solutions 20 and 23.

25. The solution formed a jelly within 13 minutes, and was not used in coagulation tests.

26. The solution was diluted to 5 times its original volume 8 minutes after adding the acid. The diluted solution did not form a jelly within 5 weeks. It probably would have formed a jelly within 15 to 20 minutes at its original concentration of 5 per cent of sodium silicate. The solution gave good aid to coagulation, though it was not as good as solutions 20 and 23.

27. The solution was diluted to 5 times its original volume 8 minutes after preparation. The solution did not form a jelly within 5 weeks. It retarded coagulation of the lake water.

28-a. The solution did not form a jelly within 5 days, and retarded coagulation of the lake water.

28-b. More sodium silicate was added to solution 28-a at the end of 5 days. After standing 24 hours, it gave good aid to coagulation. It did not form a jelly within 4 weeks.

29. The solution was diluted to 5 times its original volume 10 minutes after preparation. The aid to coagulation was not very much, and it did not form a jelly within 4 weeks.

30. The solution was diluted to 5 times its original volume 10 minutes after preparation. Excellent aid was given to coagulation, and it did not form a jelly within 4 weeks.

Changes in the Activity of Silicate Solutions

The statement has been made that the acid-treated sodium silicate solutions change in activity, depending on time of standing and alkalinity of the solution. Tables 10 to 14 show the effect of the changes on time required to produce coagulation. The solution used was a 1260 alkalinity solution which will not develop to where it gives maximum aid to coagulation as rapidly as solutions slightly more acid. More tests were made than are given in the tables, and the results for the time required to form an excellent coagulation are shown in Figue 6.

The curves are interesting in that small amounts of SiO_2 give some aid at first, and this aid appears to be about as much as the same amount gave 6 to 24 hours later. Table 10 shows that 1.5 p.p.m. of SiO_2, five minutes after preparation, shortens the time required to produce an excellent coagulation of the water from 40 minutes to 12.5 minutes, whereas 3.0 p.p.m. of the solution not only gave no aid to the coagulation but retarded it. Table 11 gives tests conducted 30 minutes after the solution was prepared. The aid given by 1.5 p.p.m. of SiO_2 was the same as for 5 minutes, but 3.0 p.p.m. produced an excellent coagulation within 7.5 minutes. Larger amounts of SiO_2 required more than 7.5 minutes, and 6.0 p.p.m. of SiO_2 retarded coagulation. At the end of 6 hours, 1.5 and 3.0 p.p.m. of SiO_2 still gave the same aid to coagulation, but 6.0 p.p.m. gave the shortest time required to produce an excellent coagulation. Amounts over the 6.0 p.p.m. lengthened the time from that required with this amount.

In 24 hours, the range of concentration which gives maximum aid to coagulation was lengthened. After 8 days, small amounts of the SiO_2 did not give as much aid as they did shortly after preparation. Evidently the solution was changing gradually, and passed through a state of condition, which greatly aids coagulation with the aluminum and iron coagulants, to one of less active state. This explains the peculiar characteristics of the two curves shown in Figure 2 in Part 1 of this discussion in the December, 1936, issue. At that time no explanation could be offered as to why the two silicate solutions gave characteristics which varied widely.

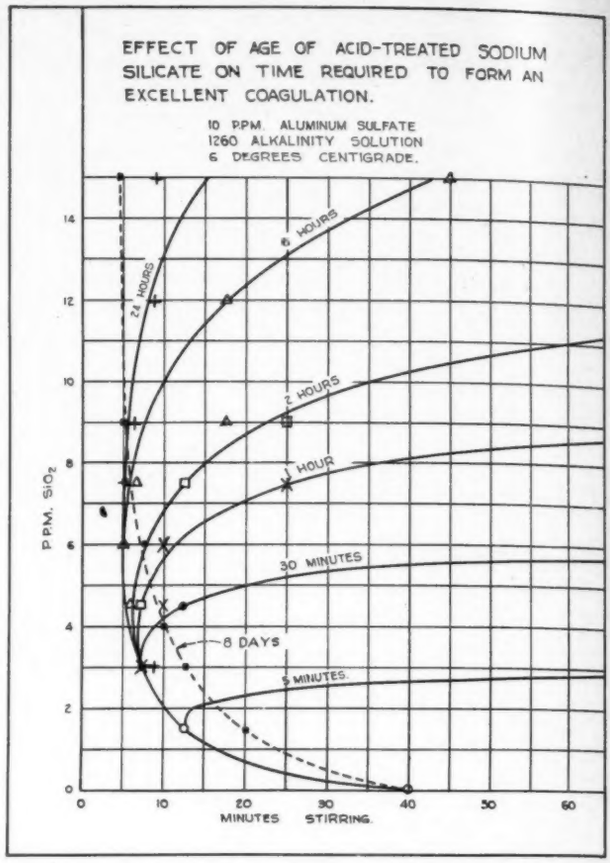


Fig. 6.—Effect of Age of Prepared Silicate Solution on Coagulation Results and Economy.

Form of Silica Which Aids Coagulation.—As the silicates are complex in structure it is not possible to state accurately the form that will aid coagulation. The data show it is a form nearly ready to produce a jelly, and indicate it may be a colloidal suspension of hydrous silica. Should this be the case, then there is considerable information on the production of this form of silica. When the silicate solution is slightly alkaline, the colloidal silica particles are negatively charged, yet this does not explain why a strongly alkaline sodium silicate solution hinders or retards coagulation.

Shortly after finding that silicon in some form would

TABLE 10.—EFFECT OF VARYING THE AMOUNT OF SILICATE ON TIME REQUIRED TO COAGULATE LAKE MICHIGAN WATER.

10 p.p.m. Aluminum sulfate; 60° C.
Solution No. 31, 1260 alkalinity.
Silicate solution used 5 minutes after preparation.

P.P.M. SiO_2	pH	Minutes Stirring Required to Form Coagulation: Just Visible	Small Particles	Fairly Good	Good	Excellent	Immense
0.0	7.3	7.5	10	12.5	22	40	...
1.5	7.3	6	7.5	8.7	10	12.5	...
3.0	7.3	10	12.5	20	....	....	...
4.5	7.3	10	30	....	....	....	...
6.0	7.3	(No coagulation visible in 30 minutes.)					
9.0	7.3	(No coagulation visible in 30 minutes.)					

Immense coagulated particles were not formed in any of the tests.

TABLE 11.—EFFECT OF VARYING THE AMOUNT OF SILICATE ON TIME REQUIRED TO COAGULATE LAKE MICHIGAN WATER.

10 p.p.m. Aluminum sulfate. Turbidity 25. 6° C.
Solution No. 31, alkalinity 1260.
Silicate solution used 30 minutes after preparation.

P.P.M.		Minutes Stirring Required to Form Coagulation					
		Just	Small	Fairly			
SiO_2	pH	Visible	Particles	Good	Good	Excellent	Immense
0.0	7.3	7.5	10	14	25	40	...
1.5	7.3	5	7	8.5	10	12.5	...
3.0	7.3	4	5	5.8	6.7	7.5	12.5
4.5	7.3	5	7.5	9	11	12.5	15
6.0	7.3	7.5	12.5	20	30	....	....
9.0	7.3	(No coagulation visible in 30 minutes.)					

TABLE 12.—EFFECT OF VARYING THE AMOUNT OF SILICATE ON TIME REQUIRED TO COAGULATE LAKE MICHIGAN WATER.

10 p.p.m. Aluminum sulfate. Turbidity 25. 6° C.
Solution No. 31, 1260 alkalinity.
Silicate solution used 6 hours after preparation.

P.P.M.		Minutes Stirring Required to Form Coagulation					
		Just	Small	Fairly			
SiO_2	pH	Visible	Particles	Good	Good	Excellent	Immense
0.0	7.3	5	7.5	11	25	40	...
1.5	7.3	3	5	7.5	10	12.5	...
3.0	7.3	3	4	5	6.2	7.5	10
4.5	7.3	3	3.7	4.3	5	7	9
6.0	7.3	3	3.5	4.0	4.5	5	7.5
7.5	7.3	3	3.7	4.3	5	7	9
9.0	7.3	7.5	12.5	15	17	20	25
12.0	7.3	7.5	12.5	15	17	20	25
15.0	7.3	7.5	12.5	25	30	40	...

TABLE 13.—EFFECT OF VARYING THE AMOUNT OF SILICATE ON TIME REQUIRED TO COAGULATE LAKE MICHIGAN WATER.

10 p.p.m. Aluminum sulfate. Turbidity 25. 6° C.
Solution No. 31, 1260 alkalinity.
Silicate solution used 24 hours after preparation.

P.P.M.		Minutes Stirring Required to Form Coagulation					
		Just	Small	Fairly			
SiO_2	pH	Visible	Particles	Good	Good	Excellent	Immense
0.0	7.3	5	10	14	25	40	....
1.5	7.3	4	5	7	10	12.5	....
3.0	7.3	3	4	5	7	10	15
4.5	7.3	3	3.7	4.3	5	7	9
6.0	7.3	3	3.5	4	4.5	5	7.5
7.5	7.3	3	3.5	4	4.5	5	7.5
9.0	7.3	3.5	4.2	5	5.8	6.7	7.5
12.0	7.3	4	5	6.2	7.5	8.7	10
15.0	7.3	4	5	6.2	7.5	8.7	10

TABLE 14.—EFFECT OF VARYING THE AMOUNT OF SILICATE ON TIME REQUIRED TO COAGULATE LAKE MICHIGAN WATER.

10 p.p.m. Aluminum sulfate. Turbidity 5. 6° C.
Solution No. 31, 1260 alkalinity.
Silicate solution used 8 days after preparation.

P.P.M.		Minutes Stirring Required to Form Coagulation					
		Just	Small	Fairly			
SiO_2	pH	Visible	Particles	Good	Good	Excellent	Immense
0.0	7.3	7.5	11	17	30	....	...
3.0	7.3	5	7.5	8.7	10	12.5	...
6.0	7.3	4	5	5.8	6.7	7.5	...
9.0	7.3	3	3.5	4	4.5	5	7.5
15.0	7.3	2.5	3	3.6	4.2	4.8	6.5
30.0	7.3	10	15	(Few large particles, but not well coagulated.)			

aid coagulation, it was thought that the aid was due to silica in the soluble state. This assumption seemed supported in that a solution prepared from silicon tetrachloride, when added after the aluminum sulfate, aided coagulation, but the fact that it did not offer aid when added prior to adding the coagulant was difficult to explain by the assumption. Solutions prepared from sodium silicate give best results when applied to the water in advance of the aluminum sulfate. If the aid is given by a substance in solution, it seems that it would have been nearly as active if applied after the coagulant, but this is not the case in such tests as have been made.

Some thought has been given to the possibility of there being a slight amount of ionized silica, and that the coagulating properties of a quadrivalent ion are brought into play. Proof that there is ionized silica has not been established. The evidence, in connection with silica added to natural waters already containing silica, seems to favor the supposition that the substance which aids coagulation is colloidal silica possessing a negative charge. Perhaps the colloidal particles form the nucleus around which the aluminum hydroxide adheres. This, however, does not explain why a partially coagulated solution is greatly aided in forming large flocculated particles by the addition of a solution prepared from silicon tetrachloride, but is not aided so greatly by an acid sodium silicate. The investigation has not progressed to the extent that an answer may be given to all the factors involved in using silica to aid coagulation, and assumptions now favored may have to be changed or modified after more work has been done.

Coagulation Experiments with Acid-Treated Sodium Silicate.—Most of the experiments which have been given so far have been on prepared solutions, that is, on distilled water to which definite amounts of certain substances, such as calcium bicarbonate, have been added. As all natural waters apparently contain silica in some form there would be no application of acid-treated sodium silicate to aid coagulation unless the results produced are better than the coagulation which may be obtained naturally. That this is the case for Lake Michigan water, is shown by experiments.

Table 9 gives the results produced by the several acid-treated sodium silicate solutions which have been mentioned already. The SiO_2 added to the water treated was kept constant in amount. Solutions having a pH of 10 to 8 gave aid to coagulation with aluminum sulfate. This is assuming that the solutions which formed a jelly within a short time would have aided coagulation had they been used before the jelly formed. Experiments conducted on other solutions with equal pH and alkalinity, in which the silicate was used before it formed a jelly, or was diluted just before the jelly formed, gave aid to the coagulation of the lake water. It is interesting to note when the solution is made slightly acid there is no tendency to gel, and instead of aiding coagulation with aluminum sulfate, it retards the coagulation. This same characteristic is true when the solution is too alkaline.

Plant Experiments.—Several pilot scale plant experiments of short duration have been run. The excellent laboratory results have been duplicated in the plant. The coagulation formed much more rapidly when the acid-treated sodium silicate was used than when aluminum sulfate alone was used, and the rate of settling was much more rapid for the silica treated water. For aluminum sulfate alone, the flocculated particles in the first part of the settling basin ranged in size up to about one-eighth inch in diameter when 8 p.p.m. of aluminum sulfate were used. With the same amount of aluminum sulfate, and the addition of approximately 2.8 to 3.5 p.p.m. of SiO_2 in the form of acid-treated sodium silicate, the particles ranged in size up to nearly one-half inch in diameter. It is needless to state that such large particles settled much more rapidly than the smaller particles. The plant solutions were made in about 300 gallon portions, containing 0.6 per cent of SiO_2. They were made first as 1.5 per cent solutions, and diluted after 1 hour.

SLUDGE DISPOSAL BY INCINERATION

Part III—Types of Incinerators—Continued

By PHILIP B. STREANDER

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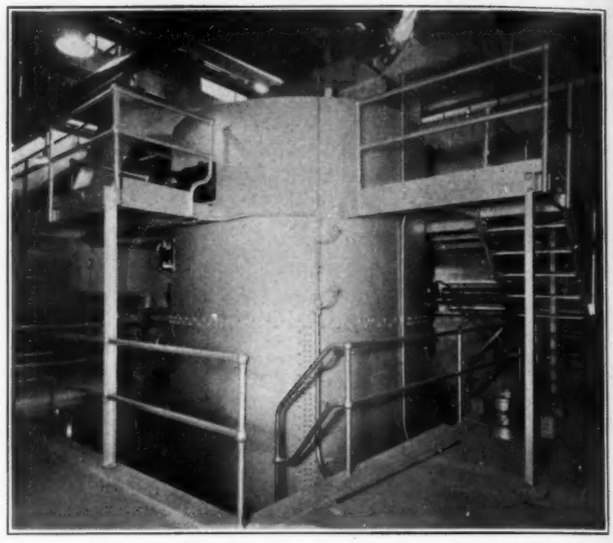
This is the third installment of a continued article, by Mr. Streander, which deals with the theory and present day practices as applied to the incineration of sewage sludges.

The first installment, which appeared in our January, 1937 issue, discussed modern methods of dewatering or drying sludges, preparatory to incineration. The second, which appeared in the April issue, discussed the heat values of sludges of various types and described incinerators of the mill-type. The present article describes and discusses features of the incinerators of the multiple-hearth type, in which the sludge is both dried and burned with the aid of mechanical rabbling (raking) from hearth to hearth.

In a near future issue the fourth and closing installment of Mr. Streander's timely series on "Sludge Disposal by Incineration" will be devoted to a discussion of the potentialities of power production in conjunction with incineration.



Nichols-Herreshoff Incinerator Recently Put in Service at Auburn's (N. Y.) New Sewage Works

Incinerators of Mechanically Ribbed Type

THE mechanically rabbled, vertical, multi-hearth type incinerator is one in which the functions of drying, combustion and clinkering are effected in a single unit. This type of incinerator is, as previously stated, patterned after the ore-roasters used in the metallurgical industries. This type furnace was developed more than 60 years ago by MacDougal in England, who modified the original Parkes furnace patented in 1850. The next major improvement was made by Herreshoff, who made many improvements in its construction, including the adaptation of hollow air-cooled rabble arms. In the copper-smelting industry this form of roaster became popular as a large part of the sulphur oxidation took place while the ore was being rabbled from hearth to hearth. In roasting, a concentrated material is fed into the top of the furnace, and the air necessary for oxidation enters through doors situated either wholly on the bottom hearth or in part on one or more of the upper hearths. Thus the air travels in a direction opposite to the ore. In some of the furnaces the air in whole or in part is admitted through the rabble arms. This type of furnace, being automatic, does uniform roasting work at a low cost and permits full control of air and temperature which are requisites of a good roast. About 90 minutes is required for the ore to pass through the furnace and during this time it is necessary to keep the ore turning over. This is done by the rabble arms and without manual attention. Many variations are used in the arrangement of multi-hearth furnaces, in the method of rabble-arm and hearth construction, in methods of introducing air into the various hearths for oxidation, and in movement of the ore from hearth to hearth. One of these is the Wedge furnace, which consists of a central air-cooled driving shaft made of ½ inch steel plate, lined with tongue and grooved fire tile. The rabble arms are secured and locked to the shaft and the shaft with the rabble arms is rotated by means of a power-driven gear wheel attached to the steel shaft of the manway.

The Nichols-Herreshoff furnace has an ingenious arm locking device which permits replacement of arms or teeth entirely from the outside of the furnace without materially cooling the furnace. The multiple-hearth roasters are built in various sizes, ranging from 6 to 23 feet outside diameter, having between 4 and 16 hearths. Almost any desired capacity unit can be obtained by proper selection of diameter and number of hearths.

The different makes of roasters are built in various sizes, the more common being between 18 and 23 feet outside diameter, having between 6 and 9 hearths with total approximate height ranging between 23 and 30 feet. Multi-hearth furnaces operate at temperatures of between 800° F. and 900° F. over the upper and lower hearths up to between 1600° F. and 1700° F. over the central hearths. Exit gases are between 700° F. and 800° F., with cooling air leaving the shaft at a temperature of between 400° F. and 500° F. Generally the cooling air is returned to the roaster effecting thereby fuel economies where ore or concentrate does not produce sufficient heat for auto-roasting. The roasting of ores entails the maintenance of comparatively constant temperatures on the various hearths and the hygroscopic and combined water in the charge does not vary to a great extent. Port areas are kept large to reduce gas velocities which usually do not exceed from 300 to 400 feet per minute. Even at these velocities the dust loss in falling from hearth to hearth is considerable. This however has been largely overcome by the use of the Cottrell process of electrical precipitation. As used in the metallurgical industry the multi-hearth mechanically rabbled

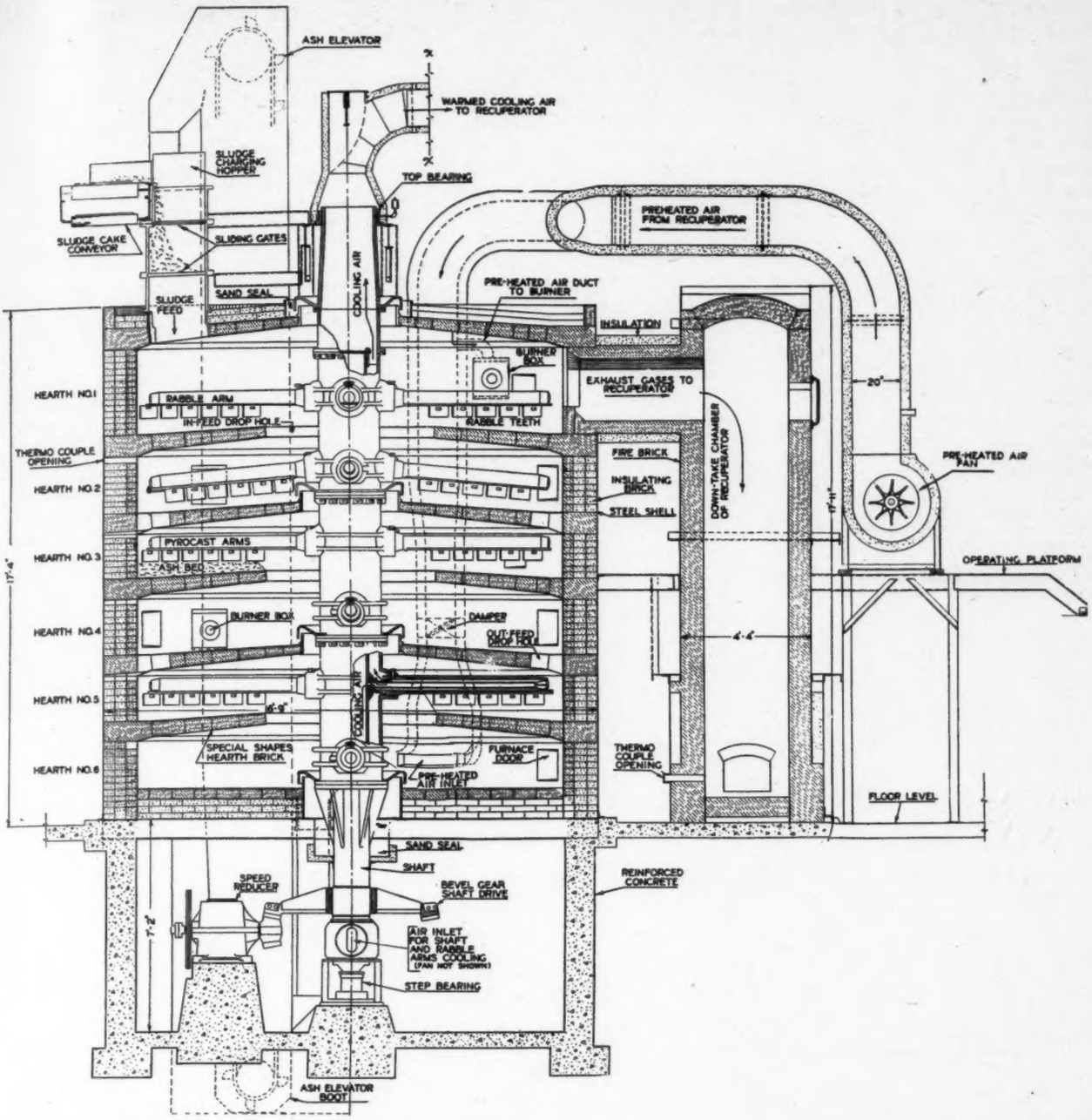


Fig. 12—Sectional Drawing of the Nichols-Herreshoff Incinerator Installed at Dearborn, Mich., and Responsible for Widespread Interest in Sludge Incineration. (Reproduced from Water Works & Sewerage, Aug., 1935.)

furnaces are for roasting purposes, handling materials having a low moisture content and superheated vapors are not developed. However, there are a large number of multiple-hearth mechanically rabbled furnaces used in other industries, such as chemical plants and paper mills, where lime sludges and other products, after partially dewatered in centrifuge or on vacuum filters, are dried and calcined.

The inherent design of this type of furnace is one in which high temperatures (2000° F. to 2500° F.) cannot be used as such temperatures would rapidly burn out the metal in the rabble arms and the air cooling shafts. To reduce the temperature to allowable limits it is therefore necessary to dilute the heat carrying medium by the introduction of air, which entails a reduction in efficiency because the weight of excess air must be brought up to furnace temperatures. Each furnace must be designed for certain average fixed conditions at which optimum efficiency will be secured. Changing conditions, met with at all sewage treatment plants, mean that operation is hardly ever carried on under the ideal design conditions. Excessive moisture content increases the zone of drying and encroaches on the volume required for efficient combustion. The combustion zone can only increase by encroaching on the space required for clinkering. Oversize units are therefore required in this type of incinerator to take care of moisture content variations; or, else, additional auxiliary fuel must be provided to effect evaporation.

Nichols-Herreshoff Incinerators

This incinerator, shown in Fig. 12, installed at Dearborn Michigan, and since at 14 or 15 other plants in operation or in various stages of construction was developed by the Nichols Engineering & Research Corporation, as the outgrowth of a close study made of the pos-

sibilities and economics of sewage-sludge incineration. These incinerators, with the exception of the method of using air preheaters and incidental improvements, closely follow the design of the well-known Nichols-Herreshoff mechanical ore roasters. At Dearborn* the sludge is that from the chemical precipitation process. The incinerator (Fig. 12) consists of a six-hearth unit having an outside diameter of 16 feet 9 inches and a furnace height of 17 feet 4 inches. The furnace wall is composed of 13½ inches of fire and insulating brick encased by a steel shell. The hearths are of the sprung type made of fire brick and provided with central and peripheral ports on alternate hearth levels. The sludge burned is that coming from dewatering vacuum filters producing a sludge-cake with about 34 per cent solids and moisture content of about 66 per cent. Even with the low volatile content of about 50 per cent the heat value runs about 5450 B.t.u.'s per pound. This incinerator, then new in the sewage field, was installed on the basis of a burning capacity of 17.5 tons of dry solids per day of 24 hours, anticipating a cake having a moisture content of 65 per cent, with only 35 per cent volatile matter and 3500 B.t.u.'s per pound.

Dewatered sludge cake is fed into the upper (No. 1) hearth at one side and is mechanically rabbled inward toward the central port or falls onto the hearth No. 2, where it is rabbled outward to the peripheral ports, through which it drops onto the next (No. 3) hearth. This rabbling continues from hearth to hearth until the bottom (No. 6) hearth is reached and the ashes are discharged through the ash outlet. The sludge generally dries on the first two hearths, combustion takes place on the third to the fifth hearth and the ash cools on the sixth hearth. Preheated air from the recuperator enters above the lower hearth and flows upward counter current to the flow of sludge. Auxiliary oil fired burners are provided on hearths 1, 2 and 4, but normally either no auxiliary fuel is required or else just one burner is used. The average gas temperature on the upper hearth is between 900° F. and 1250° F.; on hearths two and three between 1500° F. and 1700° F.; on hearth 4, 5 and 6 a gradual drop takes place from about 1200° F. to 600° F. The temperature of the exhaust gases from the incinerator runs above 1000° F. These pass through the recuperator, thus increasing the temperature of the air entering

*For a description of this pioneering installation for incinerating sewage sludge, and operating results therefrom, see—WATER WORKS AND SEWERAGE—August, 1935.—"Sludge Incineration at Dearborn" by Mark B. Owen.—Ed.

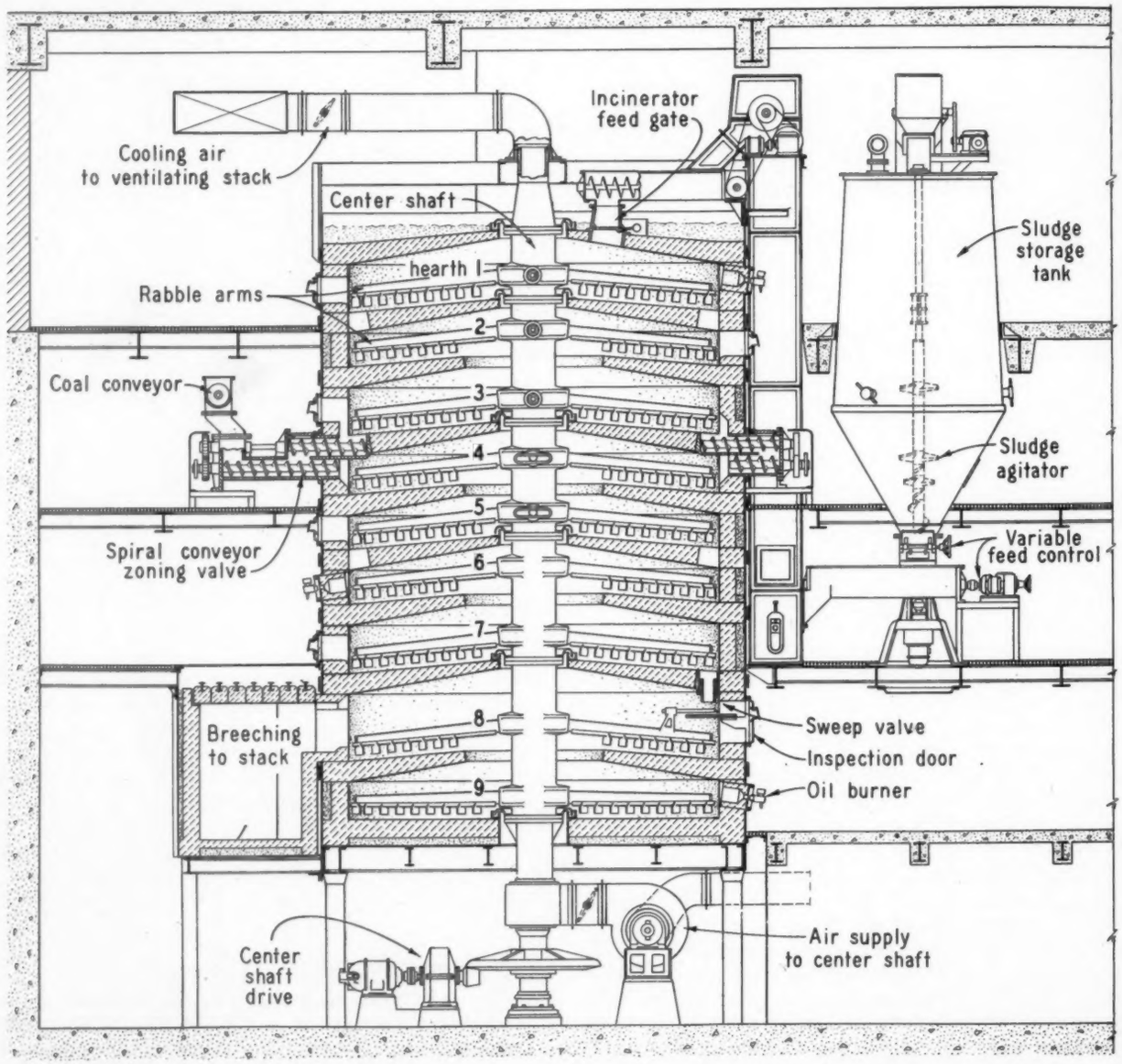


Fig. 13—Sectional Drawing of the Decarie "Petro-met" Incinerator of the Type Under Construction for Niagara Falls, N. Y.

the lower hearth to between 700° F. and 900° F. The air used in cooling the rabble arms is also passed through the recuperator. Average temperature of exit gases from the recuperator to the stack varies between 700° F. and 900° F.

The amount of moisture to be evaporated, based on specified capacities, is 32.5 tons per day. Adding to this the 17.5 tons of dry sewage solids gives a total of 50 tons of wet sludge (65% water) per day. The average weight of wet sludge burned is about 52 tons per day, of which about 17.5 tons is dry solids. Handling this amount of wet cake there was required an average of but 2 gallons of fuel oil per ton of moisture evaporated. Electric power consumed was roughly 4 K.W. hours per ton of wet sludge handled, an equivalent of about 6 K.W. hours per ton of moisture evaporated. The operating costs at Dearborn proved considerably under the guarantees of the manufacturer and a decided interest in the Nichols-Herreshoff Incinerator, and potentialities of sludge incineration, in general, was created amongst engineers.

During the past year, Nichols-Herreshoff incinerators have been placed in operation at the new sewage disposal plants at Kokomo, Ind.; New Britain, Conn.; Elmira, N. Y.; Middletown, Conn.; and Auburn, N. Y., and others are scheduled to go into operation during the next few months. Capacities of various plants under construction range from 3 up to 1200 tons wet filter cake per day produced from raw, digested, chemically precipitated and activated sludges. Some of these plants include waste heat boilers, others have only air preheaters.

Decarie Incinerator

The Decarie "Petro-met" incinerator (Fig. 13), like the Nichols-Herreshoff furnace, is patterned after the Herreshoff furnace. The "Petro-met," however, is divided into two or three separate vertical compartments, each sealed from the other. In a unit which is under construction for Niagara Falls, N. Y., to burn solids strained from sewage on a shallow coal filter, the functions of drying, burning and clinkering are separated one from the other by means of seals and auxiliary take-offs and feeds (Fig. 14). The incinerator consists of a series of sprung hearths and air-cooled mechanical rabbling arms, having a central cooling and heated air supply. The entire hearth assembly is contained in an enclosing cylindrical steel shell. The rabble arm assembly is motor driven through bevel gearing located under the hearths and arranged for variable operating speed. Center and peripheral ports are provided through the hearths for the required in and out rabbling.

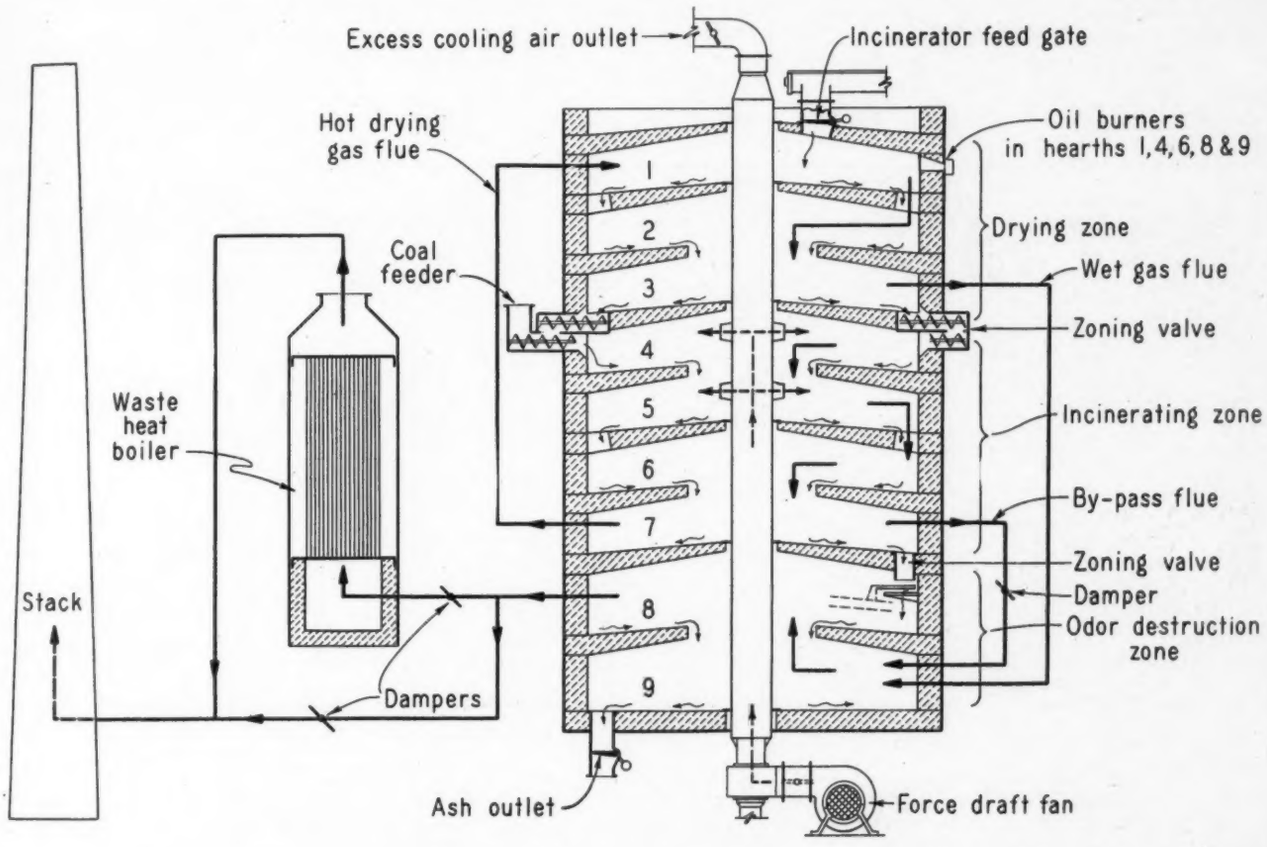


Fig. 14—Flow Diagram of 3 Compartment "Petro-met" Incinerator, Showing Routing of Sludge and Gases in Same Direction and Zoning Valves.

In operation, wet sludge is fed to the center of the upper hearth and rabbled outward to peripheral outlet ports. It is then rabbled inward to the center port of the second hearth and thence onto the third and fourth drying hearths. At the periphery of the fourth hearth there are two screw conveyor valves which remove the dried material and charge it into the first combustion hearth. Gases used for drying or evaporation of moisture in the drying hearths comes from the outlet of the lowest combustion hearth, through a flue connection between the two hearths. The temperature of the gases will range between 1100° F. and 1200° F. as they enter the upper hearth of the drying compartment and will

drop to between 500° F. and 700° F. as they leave the lower drying hearth. In this incinerator, unlike the Nichols-Herreshoff furnace, the sludge and gases flow in the *same* direction through the drying hearths (Fig. 14). Moisture laden gases from the drying hearths are passed through a flue to the bottom hearth of the incinerator for odor destruction.

Dried sludge entering the upper burning or combustion hearth is rabbled inward to a center outlet port and drops into the second burning compartment and, likewise, is rabbled in and out on the third and fourth burning hearths. From the fourth (burning) hearth the material passes to the lower hearths which form a secondary combustion and clinkering chamber. A part of the air required for combustion is that used for the cooling of the rabble arms and is blown directly into the two upper burning hearths. The balance of combustion air is drawn into the hearth through the portholes of the inspection doors. The gases required for drying are passed through a duct to the upper drying hearth and the balance of the gases are by-passed through a controlled flue to the clinkering hearth. Combustion temperatures in the burning hearths will range between 1100° F. and 1200° F. with a possible maximum of 1400° F. to 1500° F.

Burning sludge, entering the upper hearth of the combined secondary combustion and clinkering chamber, is rabbled inward to a central port through which it drops to the clinkering hearth. Here it is rabbled outward to a sealed clinker discharge valve. The temperature in the upper hearth will be between 1300° F. and 1500° F. and the temperature on the lower hearth will depend on the proportion of the gases of combustion by-passed from the lower burning hearth to the clinkering hearth. Oil burners are provided in the upper drying hearth, the burning hearth and also on the secondary combustion hearth for use in starting up the incinerator or to be used when burning low volatile or unusually wet sludges. Automatically controlled cold air inlet doors are provided to prevent the generation of excessively high temperatures. Moisture laden gases from the drying hearths may be passed through a heat exchanger and then to a chamber where they are mixed with the gases from the combustion hearths. Such an arrangement (not illustrated) uses the high temperature of the combustion gases to destroy any odors in the drying gases. An added oil burner is provided in the mixing chamber for use when incinerating sludge having a high moisture content.

Incinerators Under Development

At the present time established incinerator companies and also those engaged in the drying of various materials are making extensive studies of the problem of sludge incineration. Developments under way generally consist of units separating the function of drying or evaporation from that of burning or incineration. Several of these are described herein, the "San-Dis" being mentioned, because installations have been made of this type, and the so-called Buell type as indicating the further application of dryer practice to sludge drying and incineration.

The "San-Dis" incinerator consists of rotating, horizontal drums, offered for the drying of the sludge cake, which are directly connected to the furnaces and the final combustion chamber. The incinerators are constructed with one or more drying drums placed between the furnaces (Fig. 15). The drums are lined with heat and moisture resisting materials and have screw vanes which, during the rotation of the drum, lift the sludge and gradually move it towards the burning grate. The dried sludge leaving each drum falls into feed hoppers attached to each burning grate. The dried sludge is mechanically charged into the burning grate and is mechanically stoked. The clinker falls through the grates and is sluiced away to the dump.

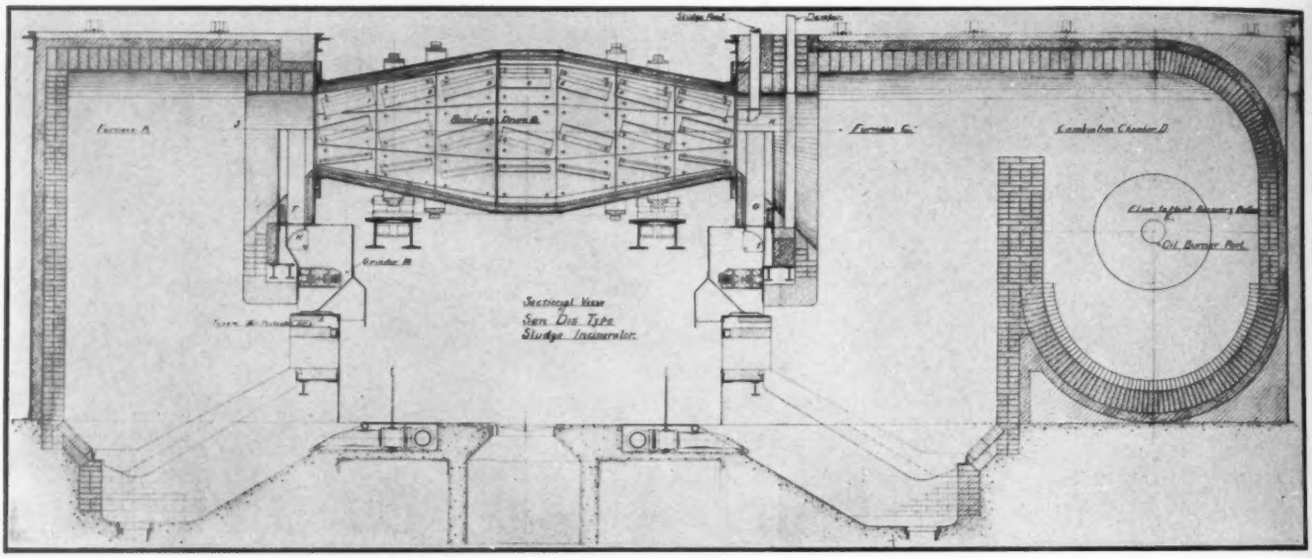


Fig. 15—"San-Dis" Incinerator of the Single Drum Type.

In operation dewatered sludge cake is periodically charged into the drying drums. The rotation of the dums, together with the lifting of the sludge by the screw vanes constantly presents sludge particles to the drying action of the hot gases passing through the drums which absorb a large part of the moisture contained in the sludge cake. Dried sludge is burned in the chamber at the end opposite the final combustion chamber and provides the heat required in drying the sludge in the drums. The drums are operated by separate motors so that rotations can be varied to suit the drying requirements. The burning compartment next to the final combustion chamber burns the dried sludge from its drying drum, whereas, final combustion takes place in the swirl

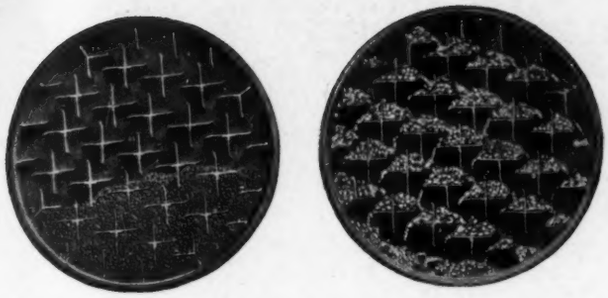


Fig. 16—Cross Section Through the Buell Cylindrical Dryer, Now Under Development. The dried material is burned in a separate furnace. Note arrangement (on right) of sludge during drum rotation.

combustion chamber shown. Gases are removed from this chamber at the center and the chamber is also used as a dust and fly-ash collector. Waste heat boilers can be installed for steam generation or recuperators may be operated to heat air for combustion.

The proposed "Buell" type incinerator is one which is characterized by the use of the Buell Dryer (Buttner System) to dry the sludge preparatory to its burning in a separate combustion chamber. The dryer is of the rotary drum type, the interior of the drum containing a patented "cruciform" design (see Fig. 16). In this design the material is opened up and turned over a number of times with each revolution of the drum. The material occupies practically the entire cross section of the drum and, with such material displacement, there is secured an intimate contact between the drying gases and the particle surface. This form of dryer has been used successfully in the drying of coals, beet sugar pulps, slurries, etc. In drying wet sludge from dewatering machines it is first mixed with a portion of previously dried sludge in an amount sufficient to prevent its adhesion to the cross-shaped shelves. This mixture enters the drum through a governor regulating the loading of the drum, which may reach about 35 per cent of the total drum content. The dryer operates on the uniflow principle—that is, the sludge and gases travel in the same direction. The air, used to evaporate the moisture in the sludge, enters the drum at a high temperature but a rapid drop occurs due to the sudden evaporation of the water. The gases leave the drum at a temperature of between 250° F. and 300° F.

An installation incorporating this type of sludge dryer would more or less follow the arrangement indicated for separate dryers and combustion chambers. Dewatered sludge cake from a centrifuge or vacuum filter would be mixed with previously dried sludge in an amount to increase the density to about 50 per cent and the mixture dried to about 10 per cent moisture. Moisture laden air from the dryer would pass through a recuperator and then be taken to the combustion chamber. The dried material would be fired through a mechanically operated stoker. Gases from the combustion chamber would be passed through the opposite side of the recuperator and then to a pre-heater to raise the temperature of the air entering the dryer. Boilers might be provided in the combustion chamber if power production seems warranted.

[The next and concluding installment is devoted to a discussion and evaluation of the potentialities of power production as a by-product from incineration.—Ed.]

Dallas Finds Chlorinated-Copperas Most Economical Coagulant

An article by Lloyd C. Billings, Superintendent Filtration Plants, Dallas, Texas, in the March (1934) issue of WATER WORKS AND SEWERAGE reported on experiences, operating results and treatment economies during three months' application of lime and chlorinated-copperas as the coagulant—the latter being ordinary ferrous sulphate oxidized with chlorine in continuous process. In his article, the following were cited amongst the advantages noted:

(1) Floc formation clean cut in particles of proper size, which resisted breaking up later. Settled well and residual floc did not choke filters.

(2) Coagulation effect not influenced by notable variations in pH between 8 and 9.

(3) Savings of $10.50 per day in coagulant costs. Represented $4,000 annual economy, notwithstanding the fact that the reduction per m.g. had been a modest 67.6 cents.

In completely oxidizing the copperas solution leaving the dry feed machine 1 pound of chlorine to each 7.8 lbs. of copperas was the required ratio.

In the Interim

Now after 2½ years' experience with chlorinated-copperas Mr. Billings presented a paper before the Southwest Section of A.W.W.A. from which the following excerpts have been drawn. [Published in the December (1936) issue of the Journal of A.W.W.A.—ED.]

The estimated yearly savings (cited in WATER WORKS AND SEWERAGE for March, 1934) based on three months' operation had been more than realized. Under the most exacting conditions chlorinating the copperas had effected a cut in the copperas dosage to one half that required when copperas and lime alone are used. The average savings during 30 months of operation with chlorinated ferrous-sulphate had amounted to $12,700 (better than $5,000 annually) and in other directions the service had been as completely satisfactory as earlier indicated.

In describing the method of producing chlorinated-copperas, Mr. Billings explained that the copperas solution flowed through Transite pipe and at a point 15 feet ahead of the discharge and chlorine is injected in the ratio of 1 pound per day for each 7.8 lbs. of ferrous sulphate (copperas) being fed. The oxidation had proved to be practically instantaneous in producing the potent and dependable coagulant of ferric-ions.

Harrison P. Eddy Dead

This last minute wired report is to notify our readers that Boston's 67-year-old Harrison Prescott Eddy, internationally known consulting sanitary engineer, died suddenly June 15 in Montreal, Que. Five hours later he was to have had conferred on him honorary membership in the Engineering Institute of Canada. He was a pioneer in sanitation, a many time honored leader in his profession.—L. H. E.

News also has just reached us that A. W. Wyman, Pasadena, Calif., long time proficient superintendent of sewage works, suddenly passed away earlier this month.

N. Y. Sewage Assn. Spring Meeting Features Exhibits

By HARRY A. FABER*
Associate Editor

INSPECTION of manufacturers' exhibits, visits to sewage treatments plants, technical papers, and the famous Sunrise Breakfast Question Box—all provided a busy meeting for the New York State Sewage Works Association in Utica on June 4th and 5th. Proudly did Secretary A. S. Bedell announce that membership in the organization had now passed the 500 mark. Classification shows there are 487 active and 20 associate members of this, the largest, sewage works association. Registration at the spring meeting was 155.

At Elmira, where a new sewage plant of the chemical treatment type has recently been placed in operation, the fall meeting of the association will be held on October 15th and 16th. Gadgets submitted in a competition of operators' original devices will be exhibited and awarded prizes at that meeting. Following the example of the highly successful Long Island section of the New York Association, a Rochester group to include members from the western part of the state is now in process of formation and will apply this year for section recognition.

To suitably celebrate the tenth anniversary of the association a committee proposes to publish a reference volume of some thirty chapters. Each chapter will be assigned to a member who is an authority in his special field of sewage work and the chapter will be written to embody the latest developments in that phase of treatment. Such a publication has been decided upon as a permanent recognition of progress since the inception of the organization. A contest is proposed to decide upon a suitable design for an emblem typical of the New York organization. The member submitting the winning design will be awarded a suitable prize, and the emblem will be employed to distinguish the letterheads, programs and publications of the association.

Operators' Annual Award Presented

For the second year, the Rating Committee awarded to that operator submitting the best report on plant operation a beautiful silver loving cup, suitably engraved. In accordance with a schedule and outline published by the committee, seven reports by as many operators were submitted in the competition. On the basis of initiative and completeness of his report, H. O. Johnson, Supt. Belgrave Sewer District, Great Neck, N. Y., was awarded the prize. In expressing his appreciation to the association, Mr. Johnson indicated that the greater knowledge and better understanding of sewage treatment, gained as a result of writing such a report, are as tangible a reward as the silver cup.

Herbert O. Johnson, Supt. of Belgrave (Long Island) Sewer District, Receives from A. F. Dappert, Chairman of the Rating Committee, the Cup Awarded Annually to the Operator Submitting the Best Records of Plant Operation. (Photograph by Courtesy N. Y. State Dept. of Health.)

C. A. Emerson, chairman of the Board of Control of the Sewage Works Federation, said that these highly successful Operators' Report contests are to be followed by similar competitions in other state associations. Because size of plant or complexity of treatment is of no significance in judging, the merit of the operator and excellence of his report have proven a just basis of award.

Particular welcome was extended to the meeting by Mayor Vincent R. Corrou of Utica in the hope that his city might profit by the preaching of "the gospel of modern sewage treatment." Lacking a sewage treatment plant, the city is not doing its share to prevent pollution of the Mohawk River. The need, however, is realized and he invited the association to return within a few years to see a modern plant in operation.

As a distinctly new and widely commended innovation, time was devoted the final day of the meeting to a brief word from each of the thirty manufacturers exhibiting products at the meeting. Under the title, "Peddler's Patter," two-minute talks by the various representatives sensibly and simply described their products and answered questions put by members. The exhibits, which ranged from miniature treatment plants to man-size manhole covers, were of value both to members who wished to see and to makers anxious to tell.

Sewage Plants—Old and New

A striking contrast was presented to members visiting the disposal works of Marcy State Hospital and the combined sewage treatment-garbage disposal plant at Herkimer. At Marcy the old Imhoff type plant is badly overloaded and a new plant is under construction to replace it. (Description of the plants and the problem of institutional sewage treatment was given in Mr. Ryon's

*Research Chemist, The Chlorine Institute, Inc., New York.

Utica Officials:

Joseph B. Shaw, City Engr. — *Hon. V. R. Corrou, Mayor*

Charles C. Agar (Albany), President of the Association

W. Gerard Hughes (Utica), Chairman Entertainment Comm.

paper, reviewed later in this article.) Attracting much attention during the visit was a demonstration of the "Triturator" as applied to the grinding of rags and other screenings at the Marcy plant.

At Herkimer the combined plant handles both sewage and garbage from a village of 10,500 population. Primary sedimentation, separate sludge digestion and garbage incineration are provided. Gas is utilized to maintain heated digestion by means of a hot-water accumulator and to insure steady high temperature incineration—avoiding smoke and incomplete combustion. As evidence of the popular appeal and civic value of this type of plant, the village of Herkimer was awarded the 1936 citation of the Mohawk Valley Towns Association for an outstanding improvement. Visitors are impressed by the economy of interlocking processes and operations under one roof.

Round Table Question Box

The very popular and useful part of the program occupied by the Sunrise Breakfast and Question Box always suffers from lack of sufficient time. With Morris M. Cohn and Chas. C. Agar presiding over the spirited discussion, the allotted two hours allowed answering of only half the questions submitted. It appears that an entire morning session devoted to such a discussion period would meet with general approval; such an allocation of time is proposed for the next meeting. Some of the questions evoking the most comment:

"Imhoff tanks are affected by foaming and other conditions—they are not a foolproof method of treatment. How are they regarded as a modern installation?"

L. V. Carpenter (Prof. San. Engr., N. Y. Univ.): For the treatment of ordinary domestic sewage many small villages have used such installations successfully for many years.

Dr. W. R. Copeland (Chief Engr., State Water Comm., Hartford, Conn.): When properly installed and operated they are useful and inexpensive means of treatment. Those at Marcy Hospital badly overloaded and cannot be considered as giving typical results.

E. Sherman Chase (Cons. Engr., Boston, Mass.): With low loads such tanks have the great advantage of being very simple to operate and have a low upkeep cost. The choice of Imhoff tank or of separate sludge digestion systems depends upon local conditions. If operation is started in cold weather, then improper digestion, foaming, and upside-down conditions may be expected to follow.

L. H. Enslow (Editor, Water Works and Sewerage, New York): Agreed that the starting time is of extreme importance. The construction time, he pointed out, should be arranged to begin operation in the spring so that proper digestion would be facilitated by warm weather temperatures. Surprisingly good results may be obtained from Imhoff tanks even when the appearance of compartments and effluent is not very satisfactory.

Chas. C. Agar (San. Engr., N. Y. S. Dept. Health, Albany): The Rochester plant recognized the importance of starting in the spring and has secured good results. There is no assurance, he indicated, that a separate sludge digestion tank will not work upside down.

F. K. Wing (Cons. Engr., Buffalo, N. Y.): Five Imhoff installations under his supervision have given satisfactory operating results—and at a cost which is economical both from installation and operation standpoints.

"What is the lowest population limit for which mechanical equipment should be provided in the plant?"

W. B. Marshall (Chain Belt Co., Milwaukee, Wis.): Mechanical equipment depends upon design of plant, type of treatment, hydraulics, and the mathematics involved. The adoption of such equipment does not eliminate necessity for some storage provision.

Prof. C. L. Walker (San. Eng. Dept., Cornell Univ., Ithaca, N. Y.): Decomposing stored sludge has objectionable biological effects and should be continuously removed.

Donald Walker (San. Engr., Amer. Well Works, New York): Compared hopper bottom tanks with those employing mechanical equipment for sludge removal and said no activated sludge type of plant is so small that it does not require such equipment.

Chas. C. Agar: Assuming separate sludge digestion in a mechanically equipped plant, it appears that to produce sufficient gas to utilize for heated digesters a minimum population figure can be set. Below 2500 insufficient sludge for digestion would be received.

"With regard to the Halvorson trickling filter (high rate of application), what is the optimum dose which should be applied?"

Mr. Agar described an installation of this type of filter at Nunda, N. Y., for treating milk wastes. Recirculation of effluent is practiced and maintains a 20 m. g. a. d. rate of application. Two months of test show the principle has merit and its success may reinstate the trickling filter method.

Dr. Copeland asked if one explanation of the success of high application rates might be due to utilization of a larger proportion of the filter area (i.e., biological growths on stone surface rather than filter surface) than is true of the usual filter.

Donald Walker: The actual rate of dosage is about 12 cu. ft. of stone per pound of B. O. D. applied—or, about seven times the rates specified by most states. Much of the dose is supplied by the recirculated effluent.

Executive Committee Members

Chas. McBreen
Chief Engineer
Orangeburg

Wm. W. Watkins
Supt. Water and Sewage, Oneonta

Vital to Herkimer's Plant

Henry W. Taylor, Cons. Engr., New York, Designed; D. B. Rasbach, City Engr., Herkimer, Supervises, and Fred McLaughlin Operates the Plant.

More stone area is in actual use, larger stone size is used, and pooling is not evidenced by this type of filter.

L. H. ENSLOW: The high rate trickling filter operates in a fashion very similar to activated sludge. Because of continuous unloading, two hours sedimentation period subsequent to filtration is essential.

MORRIS M. COHN (San. Engr., Schenectady, N. Y.): He advocates a thin film of gelatinous material—because, the less film the less flies. This explains the absence of flies on rapid rate filters.

"What provision can be made to adequately remove grease at a sewage plant?"

H. A. FABER (Research Chemist, Chlorine Institute, New York): This problem has not been adequately studied, but some type of aeration to coalesce and float grease particles is in rather general use. This method is employed especially at activated sludge type plants where grease is particularly objectionable. Could it be done efficiently, plants of all types would probably find it desirable to do so. Aeration for grease removal is to be provided at the Denver chemical treatment plant. The use of chlorine in the air supply to destroy the protective colloid effect of proteins in holding fats in solution was described. (This new use of chlorine was described in WATER WORKS AND SEWERAGE, May, 1937.) Extensive experiments with chlorinated air to increase grease removal at Baltimore were described.

L. H. ENSLOW: Chlorine will rapidly react with the protein, albuminoid, and ammonia materials before being taken up by the grease. This may explain its effectiveness. San Francisco is another large city which is making provision to remove grease in order to prevent a film of the material from floating on the bay. Mr. Enslow explained that grease separation and removal should preferably be done at the sewage plant and that an aeration period of 10 to 20 minutes might be desirable.

"What safety precautions should be provided to prevent operators falling into Imhoff tanks; that is, precautions which would meet the requirements of the N. Y. State Labor Dept.?"

MR. COHN discussed the responsibility of the plant for the safety of operators and visitors in this connection. Infection, injury, and gas asphyxiation are other possible dangers. He mentioned the striking fact that the workman's compensation rates for sewage plant operators and the number of accidents are higher than are those for industrial workers.

C. G. ANDERSEN (Supt. Sewerage, Rockville Center, N. Y.) described the use of a copper cable, strung lengthwise of the tank, which can be reached by an operator falling into a tank. This provides some protection.

"When adding lime for scum reduction and pH correction, what type of lime will prove most satisfactory?"

W. V. BRUMBAUGH (Secy., National Lime Assn., Washington, D. C.) described in detail the preparation of lime from limestone or dolomite rock by heating. The resulting calcium oxide or calcium magnesium oxide may contain silicon, iron, and aluminum as well as traces of other impurities. Such lime is obtainable in such forms as quicklime, pebble lime, ground lime, and a new pulverized lime. The high calcium lime must be slaked by adding the lime to water (with sufficient water to prevent "burning"), while the high magnesium lime is slaked by adding water to the lime until the reaction is underway (or "drownding" will take place). In the neutralization of acid, magnesium lime will be more effective than will calcium lime. Since the chemical composition may be the same but physical properties may differ, lime should be purchased on the basis of the specific purpose for which it is to be used. In general, lime is sold as chemical lime, agricultural lime, or construction lime. Chemical lime should be specified and may be purchased according to specifications of the A. W. W. A. or the A. S. T. M. A high magnesium content lime is not used for the treatment of water.

Technical Papers and Discussion

"Sewerage and Sewage Treatment in the Utica Area"—By FRANK N. THOMPSON, District Sanitary Engineer, New York State Department of Health, Utica.

Embraced by the Utica district are three counties, 300 sq. miles, and a population of 310,000. With one exception, the municipalities within this area are tributary to the Mohawk River. Few of municipalities, when installing sewerage facilities, provided sewage treatment plants. Within recent years, however, five plants have been built and placed in operation within the district—four more plants are under construction. More recent plans are due to the development, by the State Division of Sanitation, of a definite construction program. In 1940 all sewage entering the Mohawk must be treated.

Details were given as to the type of treatment provided or planned for municipal plants in each of the three counties involved. In addition to domestic sewage treatment problems, considerable industrial waste must be eliminated from the river. Wastes from bleacheries, dyehouses, and knitting mills are as yet untreated. Much work remains to be done in connection with seasonal wastes from summer hotels; but, through the influence of the State Sanitary Code, camp conditions are rapidly being corrected. The villages of Cazenovia, Little Falls, and Chittenango as well as the city of Utica are the only municipalities where conditions are in immediate need of correction.

MR. COHN, in discussing the preceding paper, suggested that a similar survey should be made of the area within which each meeting is held.

MR. J. B. SHAW (City Engineer, Utica) explained

A. H. Hale, Supt. Sewers and Plants, Brighton, N. Y.; Henry Ryon, Senior San. Engr. New York State Dept. Public Works, Albany; G. J. DeTraglia, Asst. Engr., Utica.

Discusses Garbage Digestion

Prof. W. L. Malcolm
Queens University
Kingston, Ontario

Morris M. Cohn
Sanitary Engineer
Schenectady, N. Y.

that plans for Utica's sewage treatment plant have been advancing markedly for the past two years. The meeting of the association might, he said, be helpful in stressing the need of the city for urgent action.

"Studies in the Digestion of Ground Garbage"—By Prof. William L. Malcolm, Queens University, Kingston, Ont., Canada.

Prof. Malcolm presented a resumé of his paper given under this title at the meeting of the New York Association last January (reported in Water Works and Sewerage, February, 1937). Because time for proper presentation and discussion was lacking at that time the subject was reviewed at this meeting.

A series of 55-gallon drums was used for digesters, and a second series for gas collectors. Various amounts of ground garbage (varying from 3 per cent to 5 per cent) were added to sludge and the gas produced was collected and studied. A raw sludge control was used and each mixture was run in duplicate.

The digestion study extended over a period of 150 days and regular analyses showed moisture, volatile matter, and pH to remain quite uniform throughout the entire period—with the exception of those tanks in which garbage alone was digested. In the latter case, no gas was evolved for a considerable period. The total gas production, however, was nearly the same for any mixture or for garbage alone. On the basis of gas production and digester operation, Prof. Malcolm concluded there was little qualitative or quantitative difference in the digestion of any sewage-garbage mixture.

Discussion of this paper was opened by Morris M. Cohn, who complimented Prof. Malcolm on the careful and painstaking work which the study demonstrated. He mentioned the list of earlier experiments of this nature and said they all proved garbage and sewage sludge would digest properly and would show similar characteristics. In normal proportions municipalities could carry out such digestion—though not all the problems connected with such disposal are yet solved.

Discussion prepared by Willem Rudolfs (N. J. Agr. Expt. Sta.) was read by H. H. Wagenhals (Dist. Engr., N. Y. S. Health Dept., Syracuse). The amount of garbage received at a plant would be typical of the particular city only. When screenings have been digested as garbage a comparatively low methane content gas (5.7 cu. ft. per lb. dry solids) was obtained. Gas production was increased with smaller additions of screenings. Garbage addition shows an increase in acidity of the mixture.

Mr. Rudolfs criticized the study as not including certain types of vegetable debris. The digestion temperature, he noted, was lower than an optimum condition, and the methane content of the gas was lower (with considerable hydrogen and carbon dioxide) than would be expected. Perhaps digestion was incomplete, but there were no unusual difficulties in digestion. There was no mention, he added, of dewatering and drying studies on the sludge or whether odors had been objectionable.

Mr. C. A. Emerson stressed the fact that other angles to sewage-sludge mixtures must not be overlooked. What would be the effect on sedimentation of such mixtures? Would the B. O. D. and suspendid solids overload the plant? Another difficulty might be caused by grease and scum removal—or, if it was not removed, the grease would clog nozzles and stones of trickling filters.

Mr. L. H. Enslow, in questioning the author as to composition of the gas produced, was told that methane content ranged from 40 per cent to 75 per cent, hydrogen content from 0 to 17 per cent, and the carbon dioxide content was about 26 per cent. It is important, said Mr. Enslow, that lack of uniformity in gas composition should not retard the present rapid utilization of this fuel for gas engine operation.

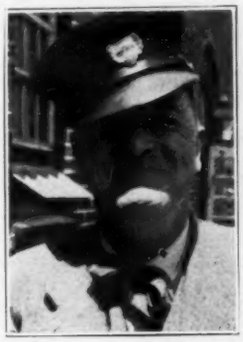
"Variable Speed Equipment and Control in Sewage Treatment"—By H. B. Diehl, Reeves Pulley Co., New York City.

The variable quality and quantity of sewage received at a treatment plant warrants the application of variable speed devices for treating the sewage. Such mechanical devices as chemical feeders, vacuum filters, pumps, screens, flocculators and other equipment may be fitted with suitable controls. Chemical feed and chlorination may be regulated to prevent overtreatment, with waste of material, or undertreatment, with loss of efficiency.

Dosage of chemicals may be made proportionate to the flow of sewage as is done at the Perth Amboy plant. Here a venturi measure of flow is transmitted through a potentiometer to electrically control the speed of lime, ferric chloride, and paper pulp addition. Such variable control may be applied to synchronize the speed of a vacuum filter with sludge delivered from sedimentation tanks. The Great Neck, L. I., plant has an installation of this type. Another type of filter control is to apply the sludge at variable speeds to a constant speed filter. This method allows maximum filter efficiency with sludge of varying characteristics. During the last five years 35 cities have installed or specified over 100 filters so equipped.

Variable speed advantages may be applied to sludge incinerators, spray drying equipment, and fine screens of the Reinsch-Wurl type. The operation of flocculators to secure most efficient building-up of floc particles was cited as an application of unquestioned value.

Discussion of this paper, prepared by M. B. Tark (Link Belt Co., Philadelphia, Pa.), was read by J. J.



Fred J. Biele
Vice. President
Huntington

George D. Rounds
Chief Engineer
Marcy State Hospital

GILBERT. Many factors, such as speed of mixing paddles, amount of chemicals, and detention time, may all be controlled by suitable automatic speed devices. Economy in the size of pumps and amounts of chemicals fed may often be realized through the use of such equipment. A number of such installations were shown by Mr. Gilbert by means of slides.

"Origin, Organization and Value of the Long Island Section of the N. Y. S. S. W. A."—By LAWRENCE LUTHER, Department of Sanitation, Freeport, L. I.

Long Island has 36 sewage treatment plants with well-trained personnel. In 1934 it was noted that few operators attended the meetings of the New York section, and Wellington Donaldson personally contacted each plant to propose a local association. The result was a meeting of 34 operators at Freeport in that year to organize. Restrictions as to membership are that the man must be active in plant operation, a resident of Long Island, and a member of the state association. Quarterly meetings, entirely educational in nature, are held.

Membership has increased from 34 to 86—which means that, at present, nearly 25 per cent of the membership of the parent association is vested in its Long Island offspring. No dues or assessments are required, as fifty cents per member is returned by the state association. At two of the four meetings laboratory demonstrations are a feature which fit with the purpose of the organization to make operators better qualified for their jobs. Permanent gain is contemplated through making the value of competently operated plants apparent to municipal officials. So satisfactory has been this program of civic education and personal improvement that "Larry" Luther (to whom much credit is due for its success) predicts six more such sections will be formed within as many years.

FRANK H. HOLLAND (Sewer Commissioner, Freeport, L. I.) sincerely praised the purpose and accomplishments of the Long Island section. He expressed the desire that members of the sewer commission of each municipality may be made to appreciate the accomplishments and needs of its operators—and further that they will prove this in a concrete way by sending them to meetings, expenses paid.

Similar appreciation for the accomplishments of the Long Island section was expressed by HARRY BROWN (Chairman Sewer Commission, Port Washington, N. Y.), who proudly introduced his operator: WILLIAM C. HAMM, the "dean of operators."

"Operating Difficulties and Enlargement of the Sewage Treatment Works at Marcy State Hospital"—By HENRY RYON, Senior Sanitary Engineer, State Department of Public Works, Albany, N. Y., and George P. Rounds, Chief Engineer, Marcy State Hospital, Marcy, N. Y.

Designed to treat sewage from 1000 population, the Marcy plant is now overloaded to the point of treating that from 3300 patients and employees. In 1921 the plant—consisting of Imhoff tanks, a sprinkling filter, final settling tank, and sludge drying bed—was built on the basis of 100 gal. per capita per day. But the average sewage flow from institutions in this state is about 175 gal. per capita per day, and at 25 per cent of the institutions the flow exceeds 200 gallons. Average characteristics of this type of sewage vary as follows: Total solids, 300 to 600 p.p.m.; B.O.D., 200 to 300 p.p.m.; and settleable solids, 2 to 19 cc. per liter.

An outstanding problem at the Marcy plant is the accumulation of heavy scum in the gas vents with little sludge settling to the bottoms of the tanks—that is, they operate "upside down." Neither stirring nor the use of lime will cause the sludge to sink. For removing the scum a rather unique device is in use. It consists of a rectangular steel bucket just fitting the gas vents and operating from the boom of a steam crane. About five cubic feet of scum is removed in each load, and is emptied on the sludge drying bed. The solids are not well digested and do not dry readily.

Characteristic of institutional sewage is the large number of rags, towels, and pieces of wearing apparel which it contains. Much of this can be salvaged from the screens and returned to the laundry.

A design more adequate to handle increases in population and in treatment problems has been selected for the new plant now under construction. Equipment will include an automatically cleaned bar screen and clarifiers equipped with skimmers. Separate sludge digesters, additional filter area and a glass covered sludge drying bed will replace the Imhoff installation. Chlorination equipment will be provided to dose influent and effluent sewage.

(1) W. Vernon Brumbaugh (Secy. National Lime Assn.), Washington, D. C. (2) Harry Brown (Chmn. Sewer Comm.), Port Washington, N. Y.; (3) Harold F. Rock (Industrial Chem. Sales Co.), Rochester, N. Y.; (4) Frederick K. Wing (Cons. Engr.), Buffalo, N. Y.; (5) Rodney E. Cook (San. Engr.), Suffolk County Health Dept., Riverhead, N. Y.; (6) Edward A. Dyer (Supt. Water and Sewerage), Cobleskill, N. Y.; (7) Robt. S. Taggart (Dist. San. Engr.), Amsterdam, N. Y.

Thirty Firms Exhibit

The following firms had exhibits at the meeting:

Inertol Co., Wallace & Tiernan Co., Robinson Clay Products Co., The Jeffrey Manufacturing Co., Pacific Flush Tank Co., Flexible Sewer-Rod Equipment Co., W. & L. E. Gurley, Royer Foundry & Machine Co., Reeves Pulley Co., Lord & Burnham Co., Wailes Dove-Hermiston Corp., Link Belt Co., R. B. Carter Co., Nichols Engineering & Research Corp., Industrial Chemical Sales Div. (W. Va. Pulp and Paper Co.), Chicago Pump Co., The International Nickel Co., General Electric Co., American Brass Co., Trohn's Supplies, Inc., The American Well Works, Johns-Manville Sales Corp., Chain Belt Co., Will Corp., Turbine Sewer Machine Sales Co., Pittsburg Equitable Meter Co., The Pardee Engineering Co. Magazines: *American City Magazine, Municipal Sanitation,* WATER WORKS AND SEWERAGE.

EDITORIAL

A.W.W.A.'s Convention and Progress

IT IS REGRETTED that this issue must go to press without the customary style of report to cover the proceedings of the 57th Annual Convention of the American Water Works Association which came to a close in Buffalo, N. Y., June 11th. Even now the press run is being held while some of the highlights of this outstanding convention are being set down as a forerunner of the more detailed account to appear in the next two issues.

Denoting progress of A. W. W. A. since its recent reorganization, a new rate in growth is revealed in its record gain of almost 300 new members since the first of this year. Equally impressive was the official count of 1,140 members and guests registered at Buffalo during the 1937 convention. Without much question better than 1,500 people attended this convention, because the 1,140 paid registrants constitute a record high in registration during the past nine years that a registration fee has been charged.

Not of least interest at Buffalo was the appearance of many new faces and many "new-old" faces—men who were attending their first Annual Convention for three, five, eight or more years. In this same direction many of those members counted as "new" are, in fact, valued old members who have renewed a suspended membership. To those who have the interest of A. W. W. A. nearest their hearts, there were two wholesome signs in these observations—namely, better times at hand for the water works man, perhaps; but, more significant, is the evidence that a renewed and more vigorous interest in A. W. W. A. has come about.

Another evidence of progress found at the 1937 convention was the number of reports of committees on specifications of equipment and materials, and standardization of practices, which had been printed or otherwise distributed prior to the convention for the purpose of securing reviews and free discussion from the floor. From such developments, as witnessed, it is evident that the production of revised material from the Committee on Water Works Practices, looking toward the earliest possible revision of important sections of A. W. W. A.'s Manual of Water Works Practices, is well under way.

Of chief concern to members of the Financing and Accounting Division was a full session devoted to introductory and preparatory discussions on the Manual of Accounting for Water Works, which is to be a valued contribution from members of this division. In another session discussion of legal phases and validity of "The Water Charge Lien" proved a center of interest.

Before the main sessions one of the highlights proved to be discussions of the future in allocation of waters, the use of streams, developments in interstate agreements and the work of the National Resources Committee, and the status of anti-pollution legislation, as presented by Duane Minard, Col. W. T. Chevalier, Dr. Abel Wolman. Another session of high interest to every water works operator was that devoted to a presentation of the status of licensing of water works operators and a review of recent attainments in this important development. Thereafter came the discussions and analysis of the allied problem in attainment of security for water works operators—namely, that of retirement and pensioning systems for water works employees, wherein methods under consideration, as already developed, were presented by managers with recent experience.

Before the Plant Maintenance and Operating Division came the most worthwhile information on the effects of air conditioning on water requirements thus far presented. Based on a barely completed nation-wide survey by the U. S. Department of Commerce, and the highly valuable factual data, collected and analyzed by Chicago's Department of Public Works, information of a concrete nature which has heretofore been non-existent, now has become available to water works men.

Amongst those topics of greatest interest to superintendents was to be found the symposium on flood experiences and that on the organization and preparations of water works to meet major catastrophes, including floods, conflagrations, earthquakes et al. Others of major interest were the round table discussions on "Detecting and Locating Leaks," "Pipe Finding," "Repairing Leaks."

To the members of the Water Purification Division, the topics of outstanding interest were covered in a symposium on "Water Softening" and another on "Corrosion Control," by such authorities as Hoover, Powell, Baylis, Spaulding, Norcom, Bardwell. New and interesting was Baylis' presentation of the effects of "Silicates as Aids to Coagulation." And the Panel Discussion on the currently important question—"To What Extent Are Water Supplies Related to the Incidence of Gastro-Enteritis?"—which only time limitations stopped, resulted in the appointment of a committee to make further and detailed studies, and report on the subject at the next meeting.

In quality and number of exhibits (115 booths and tables, occupied by 22 more exhibitors than in 1936), the Buffalo Convention was outstanding.

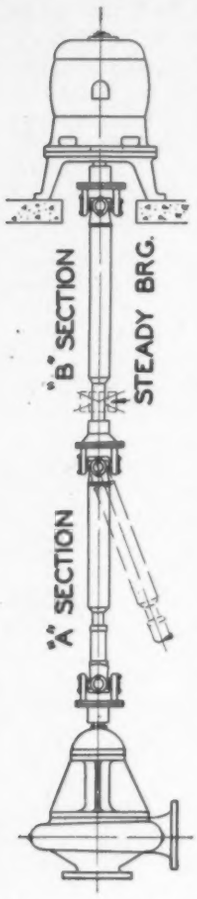
As to entertainment: Most A. W. W. A. Conventioneers have come to expect something finer each year from the hands of the Chairman of Entertainment —W. J. Orchard—as Master of Ceremonies, for the past several years. There were none, however, who could have predicted the super-quality of performance which was given by his cast made up entirely of 21 "Water Boys" and a couple of "Water Works Sweethearts," recruited from the water works field and briefly trained, as no other than Bill Orchard can. With better than 800 attending the "All Division Dinner," the show went on and on to the acclaim of an appreciative and sticking audience. Then there was an ending. A saddened, and still spell-bound, audience heard "Bill" say, that with this 12th year of service as Master of Ceremonies over convention entertainment he felt it necessary to make this his farewell performance. Two nights later this same audience had another opportunity to applaud the man, who had done so much for the enjoyment of A. W. W. A. conventions, when wholly unexpected to all (including Bill Orchard himself), A. W. W. A.'s Board of Direction had one hour earlier conferred on him an Honorary Membership in the Association. With honor to whom honor was due, so ended what many consider the most successful convention that A. W. W. A. has ever staged.

Without a word concerning the smoothness with which the machinery ran, under Secretary Jordan's rejuvenated headquarters staff, and how admirably all local arrangements were handled under Messrs. Alan Drake and Joe Gardner would be to ignore two important success contributing factors. With W. W. Hurlbut, as retiring president, reviewing the start made under the new order; and, the vigorous new president, Gene Dugger, outlining its future program, A. W. W. A. has already seen much accomplished—will see much more.

EQUIPMENT NEWS

Flexible-Shafting for Pumps

Engineers and superintendents should find much of interest in the Watson-Spicer Flexible Shaft for pump installations. This new drive offers an unusual degree of alignment flexibility for driving all types of pumps, including deepwell turbine pumps (with engines) and electric driven vertical sewage pumps.



Its construction (entirely of metal) makes use of four sets of "needle-bearings" to avoid friction losses and prevent "whining" at higher speeds. On new installations, it is claimed that costly lining up of pumps and motors becomes unnecessary as do the heavy sub-bases, usually required to maintain alignments. The extreme flexibility of the new drive shaft will permit a pump to settle five inches and tilt one inch before resetting becomes necessary. Of special interest is the fact that several Watson hollow light-weight nonwhip shafts may be coupled together, with the "Needle-Bearing" Universal joints, for driving vertical pumps. This simple solution, for an otherwise complicated and costly alignment of bearings, is claimed to operate entirely free of vibration. This interesting shaft is already being used by leading American pump manufacturers. In a new illustrated bulletin, captioned "Revolutionary Flexible Drive," these novel shafts are effectively presented and pump manufacturers using them are listed.

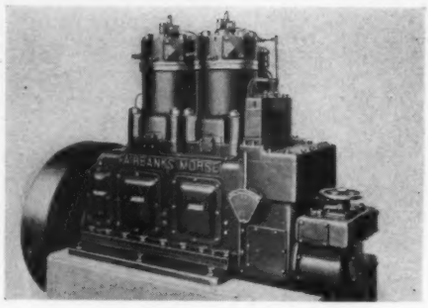
For a copy address, H. S. Watson Company, 1145 Harrison St., San Francisco, Calif.

▼

New Small Heavy-Duty Diesel

Fairbanks, Morse & Co. have developed a new Diesel engine designed to meet the demand of the smaller power users, desirous of a heavy-duty type engine productive of 60 to 90 H.P. (450 r.p.m.) for continuous service.

The new "F.M." Model 42-E is available in two or three cylinders for direct-connected, belt or electric generator drive. Its design and operation are distinctive as to simplicity and involve two important principles. Direct airless fuel oil injection, and the two cycle design with crank-case scavenging, result in the use of a minimum number of parts. All working parts are enclosed, yet are readily accessible for inspection and maintenance. Cylinder heads have been simplified by eliminating air inlet and exhaust valves with attendant operating mechanism.



"F.M." Model 42-E Diesel

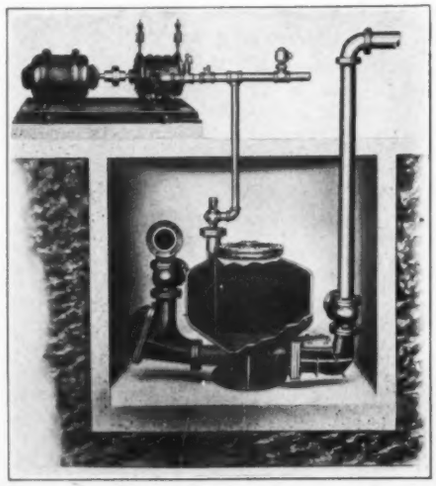
With the 8¾ in. bore and 10½ in. stroke, and power impulses on downward strokes, a uniform power output is assured with reduced size of fly-wheel, and lighter weight (more compact) construction throughout. The 42-E engines are, however, guaranteed to give the dependable service, at rated capacity, continuously without danger of overheating or strain, just as do the heavier F.M. 32 E Diesels.

For further description and specifications, write for Bulletin F.M. 42 E, address Fairbanks, Morse & Co., 900 So. Wabash Ave., Chicago, Ill.

▼

Simplified Sewage Ejector (Works Without Works)

A materially simplified sewage ejector has just been announced by Yeomans Brothers Co. (Chicago), long-established manufacturers of sewage ejectors and pumps. The improved Yeomans type "SEC" Shone Sewage Ejector, which "Works Without Works," has no floats or float switches, no air tank, no stuffing boxes, no moving parts on the inside of the ejector. It is claimed to be the first and only compressed air operated ejector of such simplicity and freedom from troublemaking parts. The result: lower costs of purchase and installation and maintenance, with higher efficiency. The air compressor operates and valves are manipulated automatically through relays energized by metal electrodes within the receiver, which may be submerged if desirable.



Yeomans Ejector

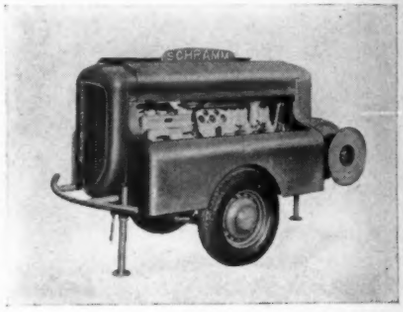
For bulletin 4050, which presents details and complete specifications covering units of 50 to 600 G.P.M. capacities, address Yeomans Brothers Co., 1433 Dayton St., Chicago.

▼

New Utility Compressor

Schramm, Inc., well known compressor and electric welder manufacturers of West Chester, Pa., have recently announced a new light-weight, compact and readily portable air-compressor known as the Schramm De Luxe "Utility" Compressor.

The new models are available in capacities of 85 and 105 cu. ft./min. in capacities,



Schramm Utility Compressors

powered with gasoline engine or Diesel—the air and gasoline tanks being under the hood. It weighs 1,500 pounds less than other models of like capacities and, thereby, can be mounted on a small half-ton truck if desired. As a semi-portable these compact "Utility" Compressors come skid-mounted. As a full-portable unit, they come spring mounted on two pneumatic tired wheels, subject to towing at 40 mi./hr. In addition, there is a stream-lined truck mounted "De Luxe" model, with tool boxes on both sides of the units. "Live-Air" hose reels are supplied as extra equipment.

Some of the features: Four cylinder vertical block with lighter pistons; five main bearings; perfect mechanical intake valve timing (with the piston travel) from a camshaft; force feed (gear driven) oil pump; electric self-starting; self-aligning clutch. Illustrated Bulletin No. 3700-WW. tells the complete story of the new Schramm "Utility" Compressors. For a copy write, SCHRAMM, Inc., West Chester, Pa.

IN CITIES OF EVERY SIZE!

Dresser-coupled water lines are serving municipalities of all classes. A few recent examples are:

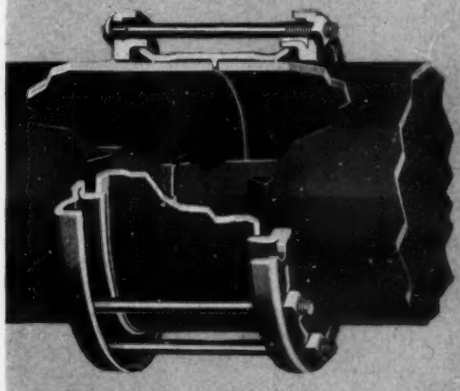
Bend, Ore.
Boulder City, Colo.
Covington, Ky.
Detroit, Mich.
Lorain, Ohio
Rochester, N.Y.

The capital of New Jersey is another city that recognizes the modern advantages of Dresser Couplings, such as: making bottle-tight joints with ordinary labor; providing flexibility in the joints to take care of Nature's forces. In laying this 28" O.D. industrial water-supply line in 1936, Dresser Couplings were used throughout.

FIVE REASONS WHY MODERN WATER LINES ARE DRESSER-COUPLED:

1. PERMANENT TIGHTNESS—proved for 50 years, on 150,000 miles of pipe.
2. FLEXIBILITY—normal pipe movements—present in every line—are absorbed.
3. SIMPLICITY—joints are "factory-made"; ordinary labor can install.
4. STRENGTH—predetermined; joints safely withstand any specified pressure.
5. TRUE ECONOMY—a truly lower joint cost throughout the life of the line.

Write for our General Catalog No. 36.



Cutaway view of Dresser Style 38 Coupling, showing working principle. Note that plain-end pipe is used. The resilient gaskets, flexing with the pipe, safely absorb pipe movements.

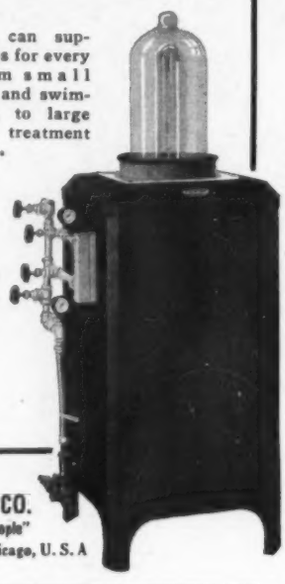
THE MODERN TREND IS TO DRESSER COUPLINGS

S. R. DRESSER MFG. COMPANY, BRADFORD, PA. • *In Canada:* **Dresser Mfg. Company, Ltd., 60 Front St., W., Toronto, Ont.**

Announcing
The New **EVERSON**
Rota-Meter Chlorinators

HERE at last is the perfect chlorinator, featuring the exclusive EVERSON *micro-control*, absolutely accurate feature, combined with the other proven EVERSON features including: Automatic Gas Absorber, Automatic Venting, and the Automatic Vacuum Break which protects against Back-Flooding.

EVERSON can supply capacities for every need—from small water works and swimming pools, to large sewage treatment plants.



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233 W. Huron St., Chicago, U. S. A

Amercoat for Sewer Protection

In a recent issue of the *"American Concrete and Steel Pipe News"* there appears an article by Ernest F. Bent, President of American Concrete and Steel Pipe Company, which tells of the long search for a means of effectively protecting sewers of monolithic concrete, or concrete pipe, against the well known sewer gas attack. The latter involves softening of concrete, due to hydrogen sulphide oxidation to sulphuric acid above the flow line in sewers. Adding materials to the concrete proper, and many trials with a variety of applied coatings, having proved deficient in effectiveness under severe sewer gas conditions, for one or more reasons, an entirely new product has come out of the many experiments and trials.

American Concrete and Steel Pipe Company announces the product under the trade name "AMERCOAT." It is a solution composed of a combination of inexpensive chemicals and materials, to produce an inert compound that is both extremely cohesive and adhesive; likewise, moisture repellant; also, acid and sulphide resistant. For the protection of centrifugally cast concrete pipes a slurry compounded from fine graded silica and sand with "AMERCOAT Solution," is introduced into the spinning pipe to produce a uniform and thoroughly bonded coating ⅛th inch or more in thickness. Upon hardening and aging the plastic coating is not subject to shatter when struck a hammer blow. Tests have shown it resistant to all of the strong acids in concentrations beyond anything possible under sewer conditions, likewise, to oil, gasoline, caustic, alcohol. In actual sewer tests where "gas attack" is the most severe on record specimens have shown no attack after 18 months of exposure to both gas and septic sewage. "AMERCOAT" has also been successfully bonded to new and old concrete and metal structures, at sewage plants, by applying as a mortar with trowel or air gun to secure two coats giving ⅛th inch thickness. For further information on this interesting material developed by a concrete pipe manufacturer, for concrete protection, address American Concrete and Steel Pipe Company, Los Angeles, Calif.

▼

"TOEC" Valves and Hydrants

A new line of water-works and sewerage equipment has recently come onto the market under the trade name of "TOEC" Valves, Hydrants, Meters, Hoists, Brass Goods, et al.

The name "TOEC" has been coined from the first letters of the words comprising the name of the manufacturer—The Oberg Engineering Corporation, of Rockland, Mass.—which is producing gate-valves, flap-valves, plug-valves, shear-gates and sluice-gates; approved fire hydrants; floor stands; hydraulic hoists; brass goods, in variety; and, also, water meters.

The announcement states that "TOEC" equipment is designed to meet the most exacting requirements of superintendents and engineers. In addition the company offers to cooperate with engineers in designing and production of special equipment for individual requirements. The "TOEC" organization, comprised of responsible and thoroughly qualified specialists, invites investigation as to financial and technical soundness. Officers are Frederick G. Oberg, President; Samuel W. Baker, Vice-Pres.; Jos. B. Studley, Treasurer. The main "TOEC" office and factory is located in Rockland, Mass.

▼

New Oxweld Regulators

A series of three new regulators, providing accurate oxygen and acetylene regulation through the entire range of welding and cutting operations, has just been announced by the Linde Air Products Co. All three regulators are of two-stage construction, essentially identical in basic design, and offer precise, efficient pressure control. One is for operations requiring oxygen pressures up to 75 lbs. per sq. in.; the second is designed for heavy-duty pressures as high as 200 lbs. per sq. in.; the third, an acetylene regulator, is a companion piece for either of the oxygen regulators.

Oxweld Regulators

Incorporated in these new regulators are several outstanding details of design, best appreciated by the operator. The stem-operated valves close with the incoming pressure, not against it. Sensitive rubber diaphragms and self-contained first stage valves are important improvements. The dials of the pressure gauges are colored and the calibrations are silvered for easy reading. The point of the pressure-adjusting screw is cradled in three ball bearings to preserve exact alignment and provide fingertips regulation through its full range.

For illustrated bulletin address the Linde Air Products Co. (Unit of Union Carbide and Carbon Corp.), New York City.

▼

"Ideal" Show Room Features Products in Action

In New York City there is a novel show room which is "Ideal" both in name and in fact. It features IDEAL products in action.

Saying it another way, Ideal Commutator Dresser Company of Sycamore, Ill., has recently moved its New York office into more expansive quarters, where a completely equipped and animated show-room has been established for display and demonstration of Ideal products in a most effective manner; namely—in action. In keeping with progress being made by "Ideal" this move was made with the intent of enhancing the service rendered by the company in the several fields to which it supplies equipment.

Through Eastern Manager R. W. Becker, and New York District Manager, F. J. Dreyfuss, Ideal Commutator Dresser Company invite all interested in motors and motor maintenance to see its modernly equipped *"Show Room of Action"* located at 61 East 11th St., New York City.

▼

Carborundum Band Honored

Carborundum Company's famed radio band of 60 instruments has been invited to play at the Great Lakes Exposition in Cleveland this summer. One day is to be called Carborundum Day, when much honored Dr. Frank J. Tone, president of the company, will be again honored at a special luncheon given, on the occasion, by the Exposition Board of Direction.

▼

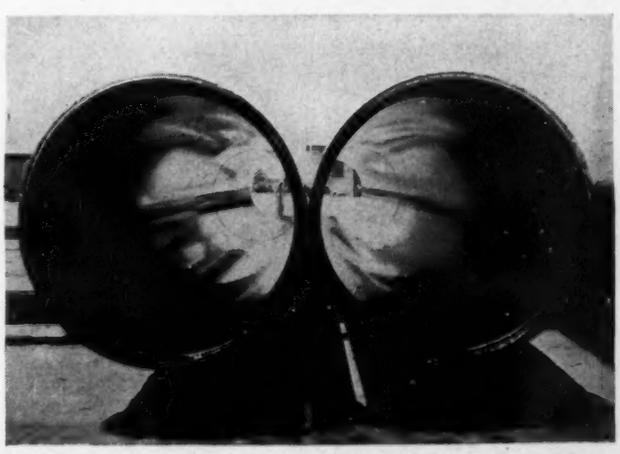
Yeomans Pumps Go West

Yeomans Brothers announce the establishment of a combination involving their company (specializing in sewage, drainage and water pumping since 1898) and the 45 year old Smith-Booth-Usher Co., pump distributors on the West Coast, who will serve as Western Distributors of Shone Ejectors, Yeomans centrifugal pumps, compressors and vacuum pumps.

Henceforth Smith-Booth-Usher Co. of Los Angeles will represent Yeomans Brothers Company in California and Arizona, having added to their staff of Sales Engineers Mr. James Lowery, former Yeomans representative in that area.

Highly Immune from the Effects of Electrolysis

Their exceptional dielectric properties make Barrett Water Works Enamels a logical choice for pipe susceptible to the stray currents so common in urban service. A quality of equal importance is their ability to provide a lastingly smooth lining—thereby effecting sound savings through reducing the coefficient of flow.



FIELD SERVICE The Barrett Company maintains a Pipe Line Service Department to assist engineers in all coating problems, and also has available Field Service men whose assistance is offered where Barrett's protective coatings are used. Inquiries are invited.

THE BARRETT COMPANY
40 RECTOR STREET NEW YORK, N. Y.

"Don't wake me for a 100 YEARS"

Yes, when the crew's through, you are through . . . for a 100 years . . . when you lay your small mains with

McWANE 2" CAST IRON PIPE

the *permanent* pipe that resists corrosion . . . reduces water losses . . . ends replacements . . . lasts for centuries. And what does this 100-year protection and security cost? only a few cents more per foot than you'd pay for a short-lived substitute. It's a fact! Investigate!

Joints—B & S
Precalked or Threaded

Sand Cast Inside and Outside

McWANE
CAST IRON PIPE COMPANY
BIRMINGHAM, ALA. SIZES 1¼" THROUGH 12"

Chicago, Dallas, Denver, Kansas City, New York, Portland, Ore.
Salt Lake City, San Francisco, Los Angeles

MEETINGS SCHEDULED:

June 21-25—STATE COLLEGE, PENNSYLVANIA (Pennsylvania State College).
Pennsylvania Sewage Works Association (June 21-23). Sec'y, L. D. Matter, State Dept. Health, Wilkes-Barre, Pa.
Pennsylvania Water Works Operators' Association. (June 23-25.) (10th Anniversary.) Sec'y, I. M. Glace, 22 S. 22nd St., Harrisburg, Pa.

June 23—BEARDSTOWN, ILL. (Masonic Temple).
Northwestern Water Plant Operators' Association. Spring Meeting. C. W. Klassen, Chief Sanitary Engr., Dept. Public Health, Springfield, Ill.

June 24—NEWTON, MASS. (Woodland Country Club).
New England Water Works Association. (Annual Outing.) Sec'y, Frank J. Gifford, 613 Statler Bldg., Boston, Mass.

Aug. 18-20—DEARBORN, MICH. (Dearborn Inn).
Central States Section A. W. W. A. (Annual Meeting.) Sec'y-Treas., H. Lloyd Nelson, 2437 Koppers Bldg., Pittsburgh, Pa.

Aug. 26-28—WILMINGTON, N. C. (Cape Fear Hotel).
North Carolina Section A. W. W. A. (Annual Meeting.) Sec'y-Treas., A. R. Hollett, University of North Carolina, Box 281, Chapel Hill, N. C.

Sept. 20-22—SANTA FE, N. M. (LaFonda Hotel).
Rocky Mountain Section A. W. W. A. (Annual Meeting.) Sec'y-Treas., B. V. Howe, State Sanitary Engineer, State Office Bldg., Denver, Colo.

Sept. 21-24—POLAND SPRINGS, MAINE (Poland Springs House).
New England Water Works Association. Sec'y, Frank J. Gifford, 613 Statler Building, Boston, Mass.

Oct. 4-6—ATLANTA, GA. (Atlanta Biltmore Hotel).
American Public Works Association (Congress). Executive Director, Frank W. Herring, 850 E. 58th St., Chicago, Ill.

Oct. 5-8—NEW YORK CITY, N. Y. (Hotel Pennsylvania).
American Public Health Association (Annual Convention). Executive Secretary, Dr. Reginald D. Atwater, 50 W. 50th St., New York City.

Oct. 5-8—NEW YORK CITY, N. Y. (Hotel Pennsylvania).
Conference of State Sanitary Engineers (Annual Convention). Sec'y-Treas., R. E. Tarbett, U. S. Public Health Service, Washington, D. C.

Oct. 13-15—ATLANTIC CITY, N. J. (Haddon Hall).
Pennsylvania Water Works Association (Annual Meeting). Sec'y, Dr. F. Herbert Snow, 327 Telegraph Bldg., Harrisburg, Pa.

Oct. 15-16—ELMIRA, N. Y. (Hotel Mark Twain).
New York State Sewage Works Association. (Fall Meeting.) Sec'y-Treas., Arthur S. Bedell, State Dept. Health, Albany, N. Y.

Oct. 18-21—AUSTIN, TEXAS (Hotel Driskoll).
Southwest Section A. W. W. A. (Annual Meeting). Sec'y-Treas., L. A. Quigley, Superintendent Water Dept., Fort Worth, Texas.

Oct. 19-20—CINCINNATI, OHIO (Netherland Plaza Hotel).
Ohio Conference on Sewage Treatment. (Annual Convention.) Sec'y, Bruce M. McDill, Dept. Health, Columbus, Ohio.

Oct. 20-23—SACRAMENTO, CALIF. (Senator Hotel).
California Section A. W. W. A. (Annual Convention). Sec'y-Treas., C. M. Hoskinson, 1140 43rd St., Sacramento, Calif.

Oct. 28-30—ST. PAUL, MINN. (Hotel not selected).
Minnesota Section A. W. W. A. (Annual Meeting). Sec'y-Treas., R. M. Finch, 416 Flour Exchange Bldg., Minneapolis, Minn.

Nov. 4-6—RICHMOND, VA. (Hotel not selected).
Virginia Section A. W. W. A. Sec'y-Treas., H. W. Snidow, Senior Assistant Engineer, State Dept. Health, Richmond, Va.

Nov. 4-6—OMAHA, NEB. (Fontenelle Hotel).
Missouri Valley Section A. W. W. A. (Annual Meeting). Sec'y-Treas., Earle L. Waterman, Professor of Sanitary Engineering, University of Iowa, Iowa City.

Nov. 8-10—GREEN BAY, WIS. (Hotel Northland).
Wisconsin Section A. W. W. A. (Annual Meeting). Sec'y-Treas., Leon A. Smith, Supt. Water Works, City Hall, Madison, Wis.

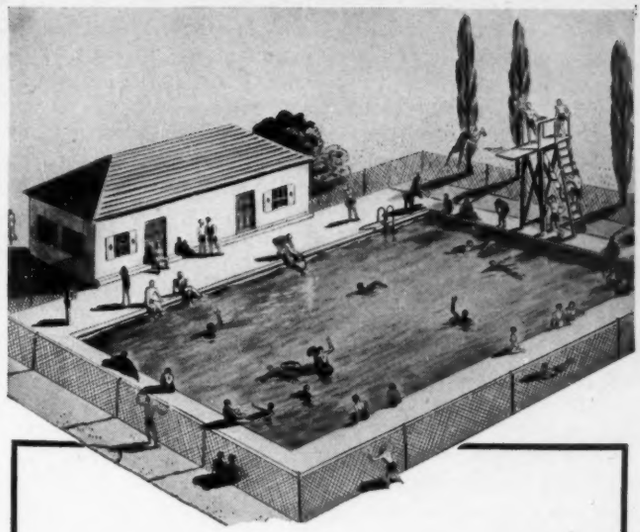
CATALOGS AND LITERATURE RECEIVED

[Any of the publications reviewed in this section can be secured from or through Water Works and Sewerage, if such be desirable.]

"Pipe Protection—The Book of"—With a background of experience involving application of 7,000 miles of pipe protection since 1928 the Hill, Hubbell & Co. Division of General Paint Corporation presents, in a brochure of the above title, the "Why and How" of the Hill, Hubbell process of pipe coating and lining. Amongst other things, the several reasons for restricting application of the process to that of a controlled mill-job, in experienced hands, are discussed. Then follows a well presented (illustrated) description of the multiple coat-wrap/coat-wrap procedure, step by step, and the technic of control. Newer is the announcement and description of the recently perfected Hill, Hubbell process of lining pipes also by a "Multi-Coat" process, involving "Biturine" (coal-tar enamel) applied by machine to pipes of 4 inches in diameter and larger. Then comes a description of special "Biturine Enamels" developed for water works use, and "Biturine Solution" for cold application to produce protection against milder corrosion. Appended, is a list of mills equipped to apply Hill, Hubbell protection, and a comprehensive "Schedule of Prices and Weights" covering the use of any of the several standard coal-tar enamels with the spiral felt wrapping under a tough hide of Kraft paper. For a copy of "The Book of Pipe Protection" address General Paint Corporation (Hill, Hubbell & Co. Division), Cleveland, Ohio.

"Morse Filter Plants"—Is a brochure from Chicago Bridge and Iron Company. It features the unique and inexpensive all steel filtration plant designed by the late Robert B. Morse, when Chief Engineer of the Washington Suburban Sanitary District. In honor of the inventor, Chicago Bridge and Iron Company, which has been allocated rights by the estate, will market these all steel plants under Mr. Morse's name. Compact, pleasing in appearance, efficient and economical, the Morse design and the operation of this type of plant is thoroughly described and effectively illustrated. A cross section sketch and flow diagram tells much of the story of the plant which won recognition when voted by *Architectural Record's* editors "America's Most Unique Water Works Plant," in a contest arranged by WATER WORKS AND SEWERAGE. The brochure also pictures the most recently completed Morse Plant at Lorton, Va., constructed for the District of Columbia. A full listing of advantages and features of consequence completes the story. Both to look through and to read, "Morse Filter Plants" is worth requesting of any district office or the main office of Chicago Bridge and Iron Co., Chicago, Ill.

"Sparling Meters"—In probably the easiest to comprehend and best illustrated bulletin ever produced by R. W. Sparling of Los Angeles, "Sparling Main-Line Meters," metering appurtenances and registers, are fully presented. Simplicity, economy and ease of installation are described and illustrated. Typical locations in suction or discharge lines are pictured, and low loss of head created is stressed for this impeller (velocity-type) instrument. In the latter direction guarantee head-loss curves are charted—none exceeding 0.5 ft., even at 8 ft./sec. velocity. Amongst the newer equipment is the electric transmitter and receiver for telemetering. Automatic chemical dosage control and sampling equipment offered, is actuated by Sparling Meter-heads. And, the



Swimming Pools Are Popular Projects

●Swimming pools are live issues in many communities. Few projects get greater popular support. Whether you plan a new pool, operate existing municipal pools, or are concerned with safeguarding private pools, you should be familiar with Permutit swimming pool water conditioning. It continuously recirculates and purifies swimming pool water at minimum cost and maximum efficiency.

Its operation is completely *automatic*. Nothing left to chance or judgment. Hundreds of swimming pools are protected by Permutit. Let us refer you to those in your vicinity.

Write for the new Permutit swimming pool manual, "Automatic Equipment for Maintaining Purity of Swimming Pool Water." It contains complete data on swimming pool construction and operation. Permutit furnishes all necessary equipment. Copy free upon request. Address The Permutit Company, Dept. G1, 330 W. 42nd St., New York, N. Y.

Permutit

Water Conditioning

portable Sparling "Metrograph" is offered for use in checking up on flows through meters of consumers, in evaluating consumer requirements or habits, and in checking for leakage on their premises. It produces a chart record, as evidence, which complaining consumers can not refute. It serves to determine proper size meter and service line. With more than 6,000 Sparlings in service, a characteristic list of users is impressive. There is much in this new 1937 Bulletin 304. Address. R. W. Sparling, 945 No. Main St., Los Angeles, or 101 Park Ave., New York City.

"Calmet"—The New Precision Meter—Well Machinery and Supply Company of Fort Worth, Texas, are producing a "different" water meter, described and illustrated in a modern, expensive and interesting 18-page catalog. The "Calumet" (a piston-type meter) is offered by the producers as a meter of guaranteed sustained precision, putting an end to dribbling-dollars passing unregistered through some of the less sensitive household meters.

Featuring the easily moved free-floating piston in oversized measuring chambers; fewer motions result per volume measured than in any other ⅝-in. meter. Results: Slower speeds and less wear of important parts; less friction and less pressure drop; less upkeep cost. The new catalog (illustrated in 3 colors) pictorially "takes apart" the "Calumet" before the reader's eyes; describes each operation and every feature from spud to spud; gives specifications. To prove the manufacturer's claims signed testimonials from endorsing operators are reproduced. A revelation to many; Calumet Meters (½ to 2 in.) have been in use on at least one important supply for eight years. For a copy of the easy-to-read and interestingly produced "Calumet" Catalog, write Well Machinery and Supply Co., Fort Worth, Texas.

"Steel Tanks in Water Treatment"—Is a new Pittsburgh-Des Moines bulletin which describes a variety of steel tanks adaptable for water treatment and filtration plants. Illustrations and line drawings portray model installations of economically constructed spiral baffled steel sedimentation basins—(with built in mixing chambers), wash-water tanks, clear well and filters. For the sedimentation basins is given design data, specifications and dimensions. At the end are tables of comparative and varying degree of water friction occurring in iron and Cast Iron pipe. Copies of this informative bulletin may be had by addressing Pittsburgh-Des Moines Steel Company, 3454 Neville Island, Pittsburgh, Pa.

Walworth, To-day—Is a new magazine produced and distributed free by America's oldest manufacturer of valves and fittings—the 95 year old Walworth Company. Volume 1, No. 1, is the 12-page May issue, others will come bi-monthly. Taking a lead from "Life," Walworth's "Today" is primarily illustrations (saving the 10,000 words each), with descriptive captions of the minimum requisite words to interpret the pictures. Of interest to sanitary engineers are the pictures of Walworth Valves and "Hi-Test" or "C.N.I." small diameter cast-iron pipe installations in water and sewage works. Walworth—"Today" will be mailed bi-monthly to those requesting it, gratis. Address, Walworth Company, 60 East 42nd St., New York City.

"Modern Tools of Science":—From Phipps and Bird, Inc., laboratory and chemicals supply house of Richmond, Va., has come a new expensive catalog with attractive embossed binding in red and black. In this 574 page catalog is presented their complete line of apparatus (amply illustrated and described), chemicals, culture media, laboratory stirrers, reagents—all alphabetically arranged. Under "W" are several pages of Water Analysis Apparatus. Missing from this new catalog, however, is the larger equipment of the firm, such as their chemical solution feeders used in the water and sewage field.

We do not judge that Phipps and Bird would like us to encourage requests for such a costly production; but, in any event, their address is 915 East Cary Street, Richmond, Va.

"Duplex Concrete Filter Bottoms"—Is an illustrated brochure, revealing features and facts concerning the Duplex filter-bottom designed and developed by the late Fred B. Leopold of Pittsburgh. Eliminating metal parts completely, glazed porcelain horizontal twin jetting nozzles are set in the top of enclosed concrete lateral channels leading off from the central flume. Through the porcelain nozzles the wash water expands beneath inverted shallow concrete boxes (Secondary Blocks) through the bottoms of which (looking up) are many tapered ⅛ in. holes spaced on 1¼ in. centers. Thus the wash water twin jets issuing from the porcelain nozzles beneath become stilled and evenly distributed upward. Thus, corrosion is precluded and effective distribution is insured, with minimum gravel depths and the least possibility of disturbance during washing. Effectively illustrated with half-tones and line drawings to scale (with complete specifications) the brochure lists a number of important modern plants equipped with these novel concrete bottoms—the Erie and Wilkinsburg, Pa., plants being the largest. For a copy of Concrete Duplex Filter Bottoms," address F. B. Leopold Co., Inc., Pittsburgh, Pa.

"Wedge Gate Valves"—In a previous issue was described the new bronze-brushed Kennedy Wedge Gate Valve, with a Standard iron body for which is listed 33 important features. In a recent Kennedy Valve bulletin this valve is profusely and effectively pictured in color to stress many of these 33 features, including the high density of metal in the body which makes for super strength without added weight. A series of pictures illustrate the ease of connecting up, disassembling, operating, re-packing and lubricating these valves. Ask for Bulletin 47 from The Kennedy Manufacturing Co., Elmira, N. Y.

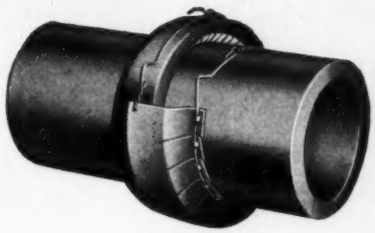
"A.A.A. Protection"—From Quigley Company, whose "Triple-A" protective coatings need no introduction to water works men, has come two new bulletins. One is devoted to specifications and applications of Quigley "Heavy Duty Black No. 20" for steel work—the inherent quality of which is "Underneath Protection," due to its property of penetrating rust not thoroughly removed in preparation. Illustrations tell why. Tough and resistant to acid, alkali and sulphurous fumes is Triple A. No. 20.

An accompanying bulletin is devoted to setting forth the merits and wide adaptability of "Triple A. No. 44 Vehicle" for Aluminum in which one brush or spray application puts on the protective black and the aluminum beautifying surface. Like Triple A. No. 20 it possesses penetrating properties; further, can be applied to damp surfaces, putting on the two coats with a single operation. A leaflet shows colors available in Triple A. Water Works and Sewerage Enamels, in addition to the black and aluminum. For Bulletin 281 B. and C-277, write Quigley Company, Inc., 56 West 45th Street, New York City.

WESTON'S GASKET AND FORM
FOR SEWER PIPE JOINTS

THE PERFECTED METHOD OF MAKING CEMENT JOINTS

L. A. WESTON
ADAMS, MASS.



- ¶ NO jute required.
- ¶ GASKET automatically aligns spigot in bell.
- ¶ Definite space in each joint for cement.
- ¶ FORM confines cement grout to lower portion of joint.
- ¶ Perfect joints made in water-bearing trenches.
- ¶ Infiltration minimized.

ANTHRAFILT
A Superior Sewage Filter Medium

Because of its light weight and greater porosity, Anthrafilt dewaters faster than sand and gives much longer filter runs. This is due to the fact that the turbid matter in sewage effluent is usually fibrous; and Anthrafilt does not clog as quickly because the particles are larger, thus greater filter bed porosity is obtained. The cost of Anthrafilt compares favorably with sand filters.

Write for detailed information and samples.

LACKAWANNA "the Diff" ANTHRACITE

THE HUDSON COAL CO.
SCRANTON, PA.

G. B. FILLMORE, Vice-President—Sales
H. H. SHAVER, Asst. Gen. Sales Agent

With "CHICAGO" AERATION EQUIPMENT
Mechanical Aeration and Air Diffusion

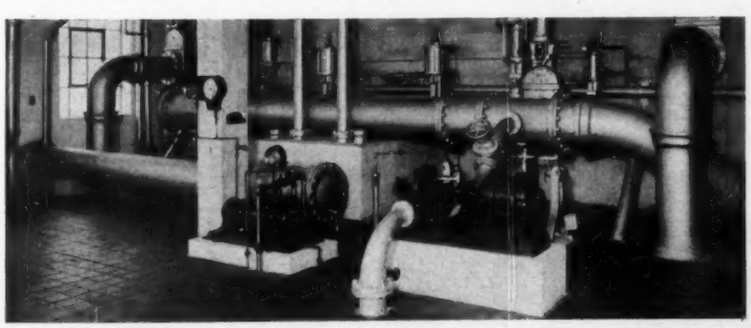
Ask for Complete Information

SEWAGE EQUIPMENT DIVISION
CHICAGO PUMP COMPANY

VACUUM—CONDENSATION—CIRCULATING—BILGE
FIRE — HOUSE — SEWAGE — SCRU-PELLER PUMPS
AERATORS—COMMINUTORS—SAMPLERS

2349 Wolfram St. Chicago, Ill.

ACIPCO CAST IRON PIPE & FITTINGS



View of pipe gallery in recently completed filter plant at Greenwood, S. C., showing variety of Acipco cast-iron pipe and fittings used; approximately 20,500 tons of Acipco Mono-Cast Centrifugal Pipe were likewise installed in new supply line and improvements to city's distribution system. Write for literature on Acipco's complete line of pipe and fittings, ranging in diameter from 2" to 36", inclusive.

AMERICAN CAST IRON PIPE COMPANY, BIRMINGHAM, ALABAMA
Dallas Pittsburgh Kansas City Chicago Minneapolis New York City Cleveland Los Angeles San Francisco

"S-O" did it..

The chief cause of Sewer Odors, hydrogen sulphide gas, is destroying *miles* of sewer line in California today! It forms sulphuric acid with the moisture in the line. The acid attacks the lime in mortar and concrete, turns them to "mush"—and there goes a costly sewerage investment. More than one California community has had to rebuild whole sewer lines years before they were even paid for—because of H_2S.

SAVE THE SEWERS..STOP THE ODORS..CHLORINATE!

Treatment with Bear Brand Chlorine can prevent the nuisance of "S-O" and stop the ravages of hydrogen sulphide. Chlorine kills the gas-generating bacteria. It neutralizes the existing gas—saves the sewers, stops the odors. Initial investment and upkeep costs for chlorinating equipment are low. And chlorination can promote economy and efficiency in sewage treatment plants by speeding up treatment time. More than a score of California communities today are protecting their sewerage investments and preventing "S-O" nuisance thru use of Bear Brand Chlorine.

ARE YOUR SEWERS PROTECTED BY CHLORINATION?

Great Western sanitary engineers are always available for consultation on such problems without charge.

Liquid Chlorine . Ammonia . Ferric Chloride

GREAT WESTERN ELECTRO-CHEMICAL CO.

9 MAIN STREET, SAN FRANCISCO
PLANT: PITTSBURG, CALIFORNIA
4151 BANDINI BLVD., LOS ANGELES

INFILCO **HYDRAULIC TRANSFER SWITCH**

Avoids Maintenance Troubles

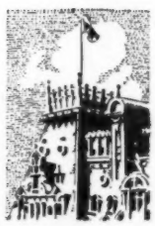
Experienced With Old-Fashioned Cocks

Offers fingertip control and assures water tightness without sticking or binding. Valve seats and disks are renewable.

Body construction, forming internal pressure and waste passages, permits gang mounting of switches and greatly simplifies piping.

Write for Bulletin 1200

INTERNATIONAL FILTER CO.
59 E. Van Buren Street, Chicago



DISTINGUISHED

Modern in every department of its service, yet never unmindful of the fine traditions that have made it One of the Few Famous Hotels in America . . . Rates begin at $5.50

BELLEVUE STRATFORD

CLAUDE H. BENNETT, General Manager
PHILADELPHIA

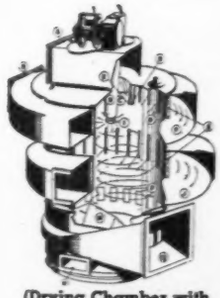
Badger Disc Meters have the largest capacities, size for size, with the least absorption of pressure. They are especially sensitive and accurate from the smallest trickle to the maximum capacity flow. Write for bulletin.

BADGER METER MFG. CO., Milwaukee, Wisconsin

BADGER Water METERS

Split-second DRYING

at low operating cost



(Drying Chamber with Centrifugal Atomizer—18,000 R.P.M.)

Learn the facts about

Spray Drying

before you decide on drying equipment.

Send for Bulletin No. 3

BOWEN

RESEARCH CORPORATION
GARWOOD, NEW JERSEY

Isn't **this** the LEAST Expensive Item in Laying Bell and Spigot Main?

Pipe costs run into real money. So does labor. Likewise, when necessary, does the job of digging up to fix leaks.

Jointing Compound that cuts laying costs—seals tightly—and resists the punishment that often makes repairs necessary—is one of the smallest items in your specifications.

MINERALEAD is a Sulphur compound — five times lighter than lead and far more resistant to vibration.

MINERALEAD comes in 10 lb. ingots—easy to handle —unchanging in its correct composition. It can be stored on the job without regard to rain or floods.

MINERALEAD is easily worked by unskilled labor—needs no caulking—makes permanently tight, trouble-free joints.

MINERALEAD has other interesting advantages which we will be glad to tell you about. The sum of all these advantages makes it—in the opinion of users — the best compound yet developed for jointing Bell and Spigot Main. Write for folder and full information.

The ATLAS MINERAL Products Company of Penna.
MERTZTOWN . . . PENNSYLVANIA

MINERALEAD

3 REASONS WHY USE STANDARD ACTIVATED ALUM OR BLACK ALUM

MANY REASONS ●

For the Chemist — 1. Better Flocculation.
For the Superintendent — 2. Better water at less cost.
For the Consumer — 3. Better tasting drinking water —and he will agree at any cost.

NEWS ● The Activated Alum Corporation has recently introduced to the field STANDARD ACTIVATED ALUM which is a basic sulphate of alumina containing the salts of Titanium and sodium and excess residual alumina for floc formation—it's priced right along with commercial sulphate of alumina.
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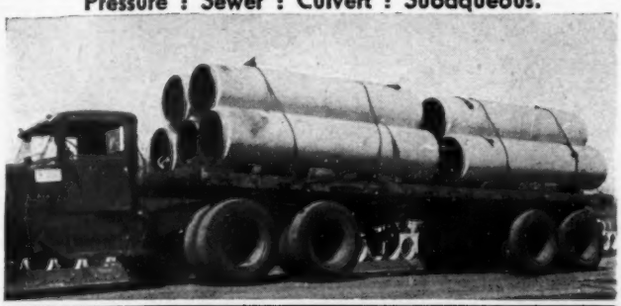

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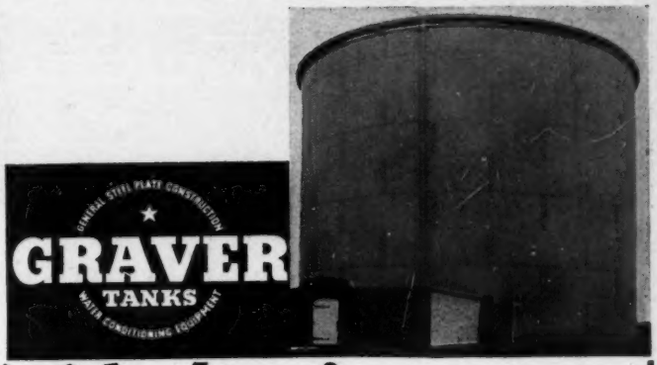

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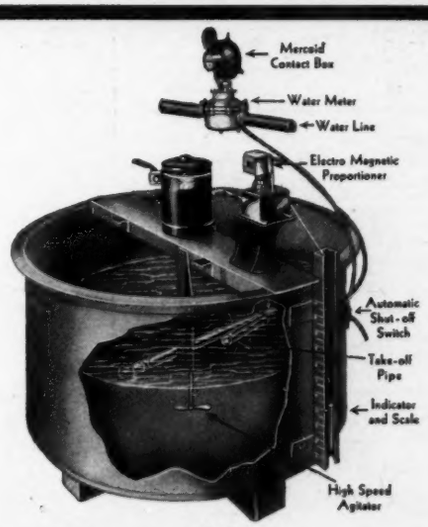

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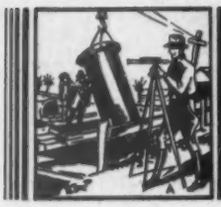

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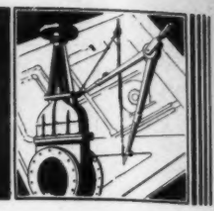

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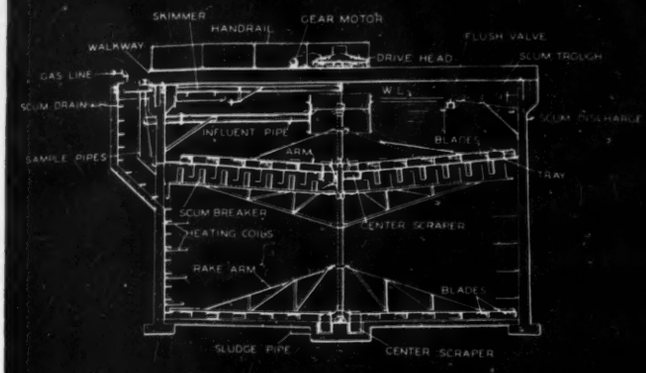

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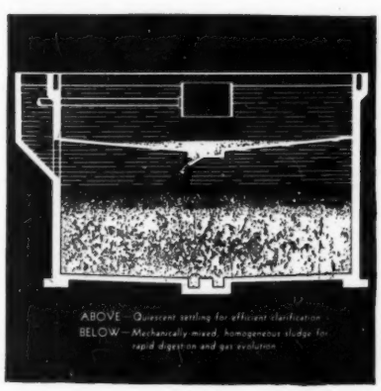
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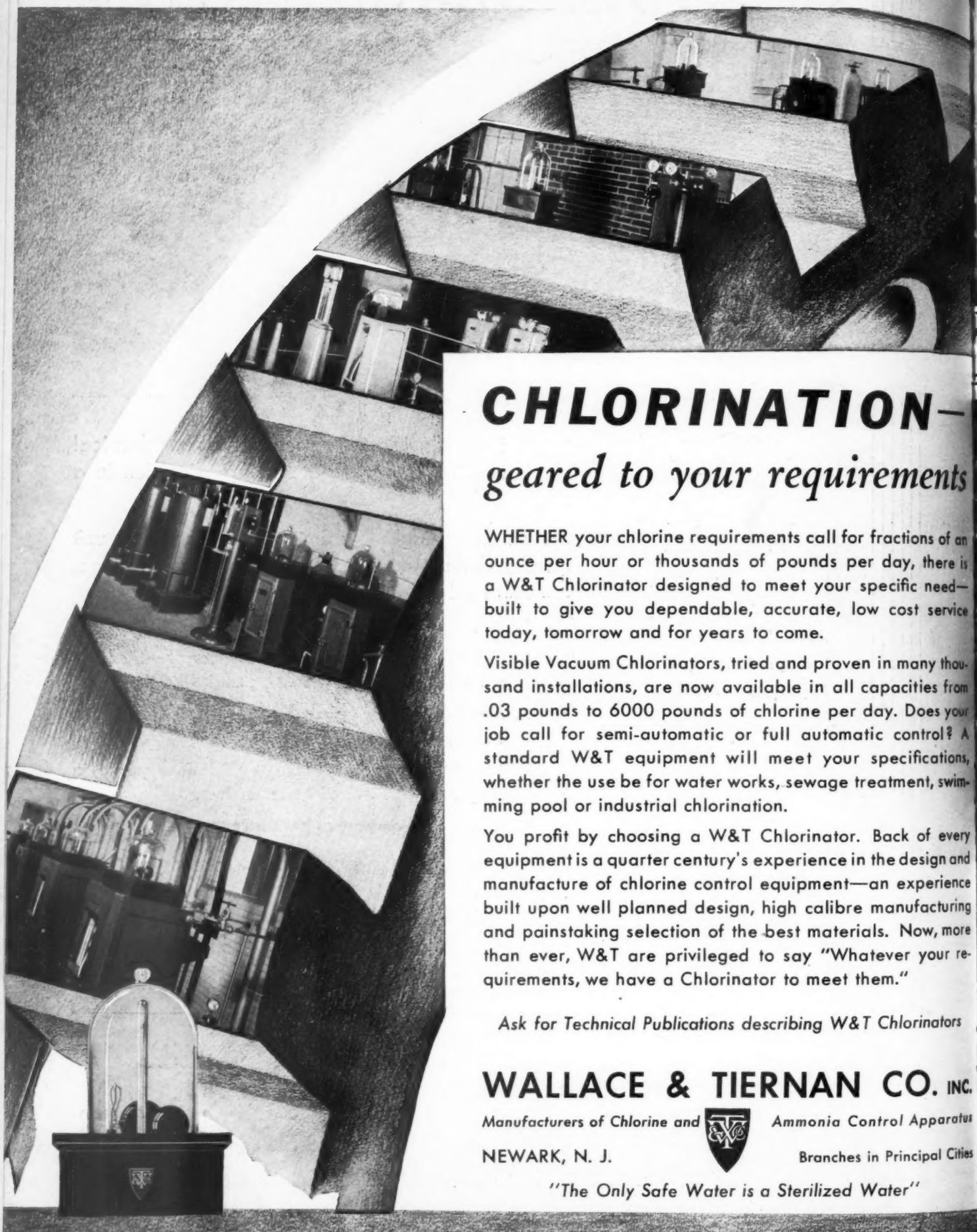

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